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# Legal Systems, National Governance and Renewable Energy Investment: Evidence from Around the World

Jia Liu, Dayong Zhang,[1] Jing Cai[2] and John Davenport[3]
Salford Business School, University of Salford, Salford M5 4WT, UK, [1]Research Institute of Economics and Management, Southwestern University of Finance and Economics, Chengdu 611130, China, [2]School of Accounting, Southwestern University of Finance and Economics, Chengdu 611130, China, and [3]Manchester Business School, University of Manchester, Manchester M13 9PL, UK
Corresponding author email: dzhang@swufe.edu.cn

**This paper examines renewable energy (RE) investment and the role of a country's legal system in shaping investment decisions. Analysing data from 236 renewable energy companies between 2000 and 2017 across the world, our study establishes that those in a common law system are more responsive to growth opportunities in RE investment, while facing greater financial constraints than their counterparts in civil law systems. Our study demonstrates that the global imbalance in RE development is caused by the influence of a country's legal system, which determines the regulatory and business ethos that impacts on the trajectory of investment, and by the varying degrees of accountability implicit in a country's governance environment. Our research raises the implication that the opportunity costs of forgone economic gains are in direct conflict with long-term environmental goals, retarding the transition from carbon-based to sustainable sources of energy, and provides insights into how development can be stimulated by fiscal incentives, favourable regulations, societal engagement, improved access to finance and the alignment of national strategies. Our findings contribute to the economic literature of legal origin theory and establish fundamental principles for refining global RE development strategy and confronting the challenge of climate change.**

## Introduction

The dire threat to the world presented by climate change has inspired a preponderance of academic literature. Studies have explored the issue from a range of perspectives, including the necessity of government subsidization in the form of Feed-in-Tariffs (FiTs), tax incentives and tradeable green certificates (Abolhosseini and Heshmati, 2014); the loss of public support as the social burden increases (Tanaka *et al.*, 2017); the need for substantial private investment (Wüstenhagen and Menichetti, 2012); and the requirement for the development of global energy governance and collective international action (Florini and Sovacool, 2009). These studies, among many others, have illuminated this branch of research, raising questions concerning social factors, commercial engagement and public policy in relation to this twenty-first century crisis.

From the outset, returns to investors have been made more attractive by government subsidies, which are essential because of the uncertain and protracted nature of RE deployment, with 20 to 25 years passing before projects begin to show positive returns (Justice, 2009). However, financial support increases power bills, entailing an inevitable political cost (Tanaka *et al.*, 2017), and governments subject to periodic re-election implement cut-backs in response to public resistance (Bloomberg, 2018; Pearson and Watson, 2012). Such adverse political reactions exert a negative

influence on RE investment, resulting in a boom-and-bust pattern of development (Barradale, 2010; Victor and Yanosek, 2011), making it abundantly clear that continued support from the public is critically important to RE development (Abdmouleh, Alammari and Gastli, 2015).

As a consequence of such countervailing influences, development across the world has been unbalanced, with some nations achieving far more than others. Countries such as the USA (Wei, Patadia and Kannen, 2010), the UK (Foxon *et al.*, 2015), Germany (Wüstenhagen and Bilharz, 2006) and Japan (Küramochi, 2015), among many others, have achieved varying degrees of success in the last decade, but RE investment has fallen significantly in all of them in recent years. There are complex causes of this phenomenon, some of which can be traced to the resistance of consumers to the financial burden that subsidizing RE imposes (Tanaka *et al.*, 2017) and some to the need of governments to develop a unified approach (Florini and Sovacool, 2009). This makes it clear that the dynamics of advancement depend, to a significant extent, on how governments develop a support system for RE development while retaining public backing. Many studies focus on social influences, which have an undoubted relevance to this inquiry (Tanaka *et al.*, 2017), while others identify pragmatic and financial issues as fundamental causes. However, as yet no studies have explored in what ways a country's legal system may have influenced RE investment in its course of development, which is the approach that our investigation adopts.

The legal origin theory argues that differences between legal systems give rise to differences in the ways business systems function (La Porta, Lopez-de-Silanes and Shleifer, 2008). The theory maintains that a common law system supports shareholder protection and a laissez-faire, market-driven approach; whereas a civil law system takes a stakeholder view, prompting government and regulatory intervention in public policy. Empirical studies offer support for the thesis that the regulatory frameworks of common law countries tend to encourage market value-driven investment in renewable energy sources (Boersma and Johnson, 2012; Brown and Hess 2016; Chasek, 2007; Jacoby, O'Sullivan and Paltsev, 2011); while policies in civil law countries, and especially those in Scandinavia with the highest corporate social responsibility (CSR) ratings (Liang and Renneboog, 2017), tend to encourage investment in RE sources (Chasek, 2007; Reiner *et al.*, 2006; Renn and Marshall, 2016; Szulecki *et al.*, 2016).

Our study pursues a similar line of inquiry in an area that has not yet been explored, examining how different nations invest in RE development and how its growth may be constrained by financial resources, systems of national governance and, above all, the nature of their legal systems. As we shall argue, a country's legal system may significantly shape how RE developments progress.

Such a line of inquiry is both opportune and crucial to inform global policy-making and commercial development, at a time when many countries have started to formulate national strategies for RE development.[1] As calls to combat climate change grow ever more strident, an investigation into the impediments that may constrain RE development is essential to help deliver solutions to what may well become an existential threat. Research in this area is therefore timely and critical from commercial, social and humanitarian perspectives.

The primary objective of our study is, therefore, to analyse how cross-country differences in legal systems and national governance influence RE investment in an international context. We focus on the application of fundamental principles underpinning the investment decisions of renewable energy companies, exploring how RE development varies across countries under different legal systems and how this process is influenced by systems of national governance. We therefore investigate firm-level investment of 236 RE companies between 2000 and 2017 across the world, seeking to address four research questions: (1) Which legal system most effectively encourages investment in RE sources? (2) Do companies specializing in creating RE sources face greater financial constraints under a common law system than companies operating under a civil law system? (3) Do growth prospects in RE have a greater impact on the investment decision in a common law system than in a civil law system? (4) Does national governance

[1]Investment in renewable energy on a global scale has grown rapidly in recent years, achieving a record level of US$312.2 billion in 2015, with acquisition activities in clean energy continuing to rise to over US$100 billion during 2016 (Bloomberg, 2018). In 2015, investment in renewable energy sources in developing economies overtook investment in developed countries, with strong commitments from China, India and Brazil likely to make them significant players in the coming decade.

ultimately influence RE investment decisions at the firm level?

Our study derives several significant findings. First, we provide evidence of the global imbalance in RE investment and an empirically based account of this phenomenon. Second, companies in civil law systems face lower financial constraints in RE development than companies in common law systems, supporting the contention that such disparities occur, in part, because governments in civil law countries tend to be more interventionist, adhering to CSR principles, and are therefore more likely to adopt policies for the subsidization of RE. In common law countries, however, where laissez-faire systems render markets pre-eminent and centralized support is controversial and intermittent, fiscal pragmatism makes it difficult for governments to extend subsidies or financial providers to offer finance for RE projects, which are essentially CSR-driven and carry a perceived high risk. Third, companies in common law countries are more responsive to growth prospects of RE investments than companies in civil law countries, because their decisions are constrained by a market-based system that is strongly protective of investors' rights, compelling them to pursue value-enhancing developments; whereas companies in civil law countries are inspired primarily by a desire to increase social wealth and satisfy CSR ideals through their RE developments. Fourth, country-level systems of governance facilitate the financing of RE investment in civil law jurisdictions because their ethos favours environmental, social and governance (ESG) principles, which are implicit in actors' behaviours at both national and corporate levels. Conversely, in a common law system, in the face of powerful market forces, a system of country-level governance does not modify the decisions of financial providers to eschew RE projects that do not offer returns in a timescale commensurate with investors' requirements.

The major contribution of our research is to extend this strand of literature into an investigation of how cross-country differences in legal systems influence RE investment in an international context. Our study offers a new insight into how the contention between economic gains and long-term environmental goals has retarded the transition from fossil fuels to non-polluting sources of energy, suggesting how this can be ameliorated by favourable government policies, benign regulation and financial support from government, creditors and investors to stimulate private-sector investment. Our investigation establishes that the transition towards RE would be more likely to succeed if nations collaborated to align national strategies, with individual governments making measurable commitments to sustain such initiatives. This requires policy-makers to undertake stable programmes for change (Justice, 2009) that involve not only the regulatory and corporate sectors, but also national and international communities, without whose backing development will suffer periodic interruptions (Shrimali, Lynes and Indvik, 2015). We are confident that our research informs the long-term strategies that governments and the energy sector should adopt in the transition from carbon-based to sustainable sources of power, offering policy-makers and regulators guidance on how to facilitate RE development at national, continental and global levels.

The rest of the paper is organized as follows. The second section reviews theories and literature and proposes our hypotheses. The third section discusses methodological issues. The fourth section presents and discusses the empirical results. The fifth section concludes with recommendations for future research and a policy agenda.

## Literature review and hypothesis development

The broad economic and social significance of the legal framework governs corporate conduct. The legal origin hypothesis explicitly acknowledges that a legal system determines in whose interests a company should be run. The fundamentals of the legal system establish the legal rights of investors and creditors (Djankov, McLiesh and Shleifer, 2007) and govern the efficiency of contract enforcement and accountability. Different legal systems impose on corporate organizations varying degrees of accountability to stakeholders, incorporating distinctively different legal protections and levels of enforcement. Disparities between legal traditions have a powerful impact on real activity, leading to cross-country differences in long-run rates of economic development. This socio-political mechanism gives rise to divergent financial systems, which shape the regulation and working of financial markets, capital accumulation and allocation, and the growth of corporate value (La Porta *et al.*, 1997, 1998).

La Porta, Lopez-de-Silanes and Shleifer (2008) assert that a common law system, based on the English legal tradition, offers the greatest protection to investors, with legal safeguards incorporated to prevent expropriation by corporate insiders and to promote wealth creation through encouraging value-enhancing investment by outsiders (Shleifer and Vishney, 1997). In common law systems, well-developed and strongly regulated stock markets dominate, protecting shareholders by enforcing corporate transparency and accountability, underpinned by company law and mandatory accounting standards (Wurgler, 2000). These market-based systems adopt the precepts of laissez-faire, which deprecate government intervention in economies and emphasize the supremacy of market mechanisms, granting primacy to shareholders' interests. Such a focus constrains managers to investing in wealth-creating projects that offer the prospect of growth commensurate with their investors' needs.

In civil law systems, in contrast, multi-stakeholder forms of governance are reinforced by differing principles and practices, emphasizing a perspective that privileges the complex requirements of a much wider range of corporate stakeholders (Adams, 1998). Such systems incorporate centralized government control and are more interventionist than their counterparts in common law countries (Mahoney, 2001; Pistor, 2013), while encouraging a universal banking system within a regulatory environment favouring a stakeholder perspective (Allen, Carletti and Marquez, 2015; Magill, Quinzii and Rochet, 2015). In such a legal system, universal banking takes a more active role, mobilizing capital, overseeing investment decisions of corporate managers, providing risk management vehicles, exerting central control and imposing regulation (Kwok and Tadesse, 2006; Purda, 2008).

The preponderance of research confirms that an organic relationship exists between a legal system and the businesses and transactions that it regulates, and that this strongly influences the manner in which investments are determined and financed. These propositions provide the basis for the development of our hypotheses.

### *Legal origins and renewable energy investment*

The information asymmetric hypothesis argues that imperfections in the capital market increase the cost of external finance and create binding financing constraints on a firm's fixed investments. The cost wedge between internal and external funds leads the firm to rely more on internal cash flow to finance investment projects, making it extremely sensitive to internal funds. As small, young, high-risk companies are less able to generate sufficient internal capital to finance projects, especially at the inception and developmental stages, they have to invest less than the first-best optimum or bypass value-enhancing investment projects altogether, constraining further growth and hence economic development (Liu, 2013; Thakor and Wilson, 1995).

Relative to other industrial sectors, the RE sector has some distinctive features. First, being in an emerging industry, it has a shorter history, with no legacy of stability or success to encourage external investment financing (Zhang, Cao and Zou, 2016). Second, investments in RE are risky, with returns to equity made over periods of 20 to 25 years (Justice, 2009). Such lengthy payback periods are caused, in part, by the need to create infrastructure, whereas infrastructure already exists in the traditional energy (TE) sector, along with a developed technology to support conventional development. Third, successful implementation relies heavily on policy support (Tanaka *et al.*, 2017) because renewable energy production is only marginally competitive, if at all, in comparison to conventional technologies (Bloomberg, 2018). Without active government support, companies in general, and those in common law countries in particular, will be wary of investment in this sector (Abdmouleh, Alammari and Gastli, 2015; Shrimali, Lynes and Indvik, 2015). Fourth, in spite of being beset by many uncertainties, the development of the RE sector is of considerable strategic importance for all nations, given the dire threats of global warming, and since all countries must pledge to commit assets to these vital developments, their long-term future is assured.

Since the RE industry is new and evolving, firms undertaking such developments tend to be much smaller than their competitors in the traditional energy sector and lack an established legacy of success (see Table 4 later), hence carrying high levels of risk. As a consequence, they typically experience the greatest informational opacity problems (Myers and Majluf, 1984) and must surmount high hurdles to secure external funds (Justice, 2009). In the face of severely adverse selection problems, they will be excluded from debt and capital

markets altogether. Dynamic RE firms, therefore, face liquidity problems and are less able to take on investment opportunities and achieve economies of scale rendering them competitive in the market (Chittenden, Hall and Hutchinson, 1996; Liu and Pang, 2009).

Such financial constraints may, however, be alleviated in civil law systems, which have an interventionist ethos (La Porta, Lopez-de-Silanes and Shleifer, 2008; Mahoney, 2001) that enables politicians to pursue policies that act in the interests of social well-being. Their corporate environments favour capital allocation through powerful banking institutions while placing emphasis on a stakeholder perspective and social values (Allen, Carletti and Marquez, 2015).

Countries in the Nordic bloc, which exemplify these social characteristics, sustain a universalist welfare state, with the objectives of enhancing individual autonomy and increasing social wealth (Hicks, 2000; McWhinny, 2013). Although there are differences between countries in the grouping, the Scandinavian model of social democracy incorporates common policies for promoting economic security and opportunity within a capitalist framework (Kenworthy, 2014). Similarly, countries such as Germany engage in what Dore (2000) refers to as 'welfare capitalism', where executives are mainly influenced by diverse stakeholders such as banks, employees and firms with interlocking shareholdings (Adams, 1998). Such systems engender a social environment within which governments care for all stakeholders rather than the few, and are more inclined to promote the deployment of RE by offering subsidies to developers.[2] Additionally, investment finance in civil law systems is primarily sourced by banks, whose superior insider knowledge and monitoring powers mitigate the credit risk that they will face (Purda, 2008), and whose approval of CSR principles makes them more likely to offer RE firms favourable access to finance (Cheng, Ioannou and Serafeim, 2014). For example, driven by CSR ideals, the Nordic Investment Bank grants loans for sustainable business projects of between 5 and 25 years, which appears to be a rather liberal lending regime (Nordic Investment Bank, 2019). In this benign social milieu, it follows that RE firms will have lower financing constraints, with investment cash flow sensitivity reduced by the favourable support of government and financial institutions.

In comparison, RE firms in common law countries may encounter more severe financial limitations, since funding managers are committed to minimizing credit risk and financing investments in what are primarily CSR projects exposes them to unacceptable investment outcomes. In these laissez-faire systems, where markets are pre-eminent and subsidies politically controversial and intermittently offered, commercial pragmatism makes it more difficult for firms to raise finance for RE development. Political expediency gives rise to the relative instability of subsidization, which often results in retrenchment (Barradale, 2010; Pearson and Watson, 2012; Shrimali, Lynes and Indvik, 2015; Victor and Yanosek, 2011), and prevailing market-based philosophies will also deter banks and investors from funding projects with uncertain returns. Renewable energy firms in common law countries will, as a consequence, experience greater constraints in securing finance than those in civil law countries.

Based on the foregoing discussions, we derive our first hypothesis:

*H1*: Renewable energy firms in a common law system have higher financing constraints in investment (i.e. are more sensitive to internal cash flow) than their counterparts in a civil law system.

The legal origin hypothesis maintains that disparities in the nature of legal systems determine the strength of investors' protections (La Porta, Lopez-de-Silanes and Shleifer, 2008; La Porta *et al.*, 1996). A common law system promotes strong legal protection for shareholders and fosters value-maximizing investment (La Porta *et al.*, 1998), enforcing informational transparency, which enables the market to make informed judgements about the projects that managers select (Wurgler, 2000). The high degree of accountability that such an environment ensures, underpinned by effective contractual arrangements for shareholders, strongly impels managers to invest in projects that minimize risk and promise income and capital growth within a time-frame consonant with their investors' requirements. Since RE projects

[2]The Swedish and Norwegian governments have recently extended their Green Certificate scheme, subsidizing RE deployment, that they have been operating since 2012 (Climate Action, 2017); while in Germany, electricity from renewable sources is mainly supported through a market premium scheme, FiTs and low-interest loans (RES Legal, 2017).

are fundamentally CSR developments with no immediately foreseeable prospects of success (Justice, 2009), managers will exercise excessive caution when investing in such technologies, in the interests of their shareholders, leading to their sensitivity to growth opportunities in RE development.

Conversely, as we have argued, the regulatory and cultural environment in civil law regimes privileges a stakeholder perspective rather than the primacy of shareholders, with the social welfare systems prevailing explicitly favouring the CSR principles that buttress a universalist social philosophy. Firms in Nordic countries have the highest ratings of CSR (Liang and Renneboog, 2017), sharing ideals supportive of social well-being, which is suggestive of an ethos that permeates both the regulatory and corporate sectors. Further, civil law countries have governments that are predisposed towards active, centralized control (La Porta, Lopez-de-Silanes and Shleifer, 2008; Mahoney, 2001). This facilitates economic intervention by the state, which produces a regulatory environment strongly supportive of the stakeholder perspective (Magill, Quinzii and Rochet, 2015) and engenders a commitment to fostering social wealth (Liang and Renneboog, 2017). Muira (2012) reports that the UK allocates 19.8% of gross domestic product (GDP) to social spending; Germany 26.6%; France 28.3%; and Sweden 32.5%, providing evidence to support the assertion that governments' commitment to public well-being prevails more strongly in civil than in common law countries. This tendency to favour social wealth creation, reinforced by stronger government control, interventionism and support, is likely to render managers' investment decisions on RE less sensitive to the prospects of growth potential than those of their counterparts in common law countries.

Based on the foregoing discussions, we derive our second hypothesis:

*H2*: Renewable energy firms in a common law system are more sensitive to prospects of growth opportunities, viz Tobin's Q, than their counterparts in a civil law system.

### *National governance and renewable energy investment*

Cross-country research into the nexus of legal systems and corporate finance argues that a legal system creates a nurturing environment supported by a governance mechanism that enhances accountability, transparent disclosure, legal oversight for capital investment and the creation of corporate value (Hillier *et al.*, 2011). The nature of a governance system determines how and to what degree accountability is enforced to protect stakeholders' interests by means of regulation, rule of law, and voice and accountability. Regulatory quality reflects the ability of government to formulate and implement sound policies and regulations that permit and promote private-sector development, requiring nations to maintain robust systems of governance for enforcing legal requirements and accountability, as well as accommodating stakeholder expectations. The power of these systems diminishes the informational advantage of corporate insiders and, consequently, reduces the cost of external finance (Demirgüç-Kunt and Maksimovic, 1999). In addition, the functioning of financial systems, underpinned by the rule of law, is subject to regulations governing conduct to ensure that standards of financial probity are maintained and investors and customers protected. In the event of breach, the rule of law will be invoked and those found guilty of transgression held accountable. This necessitates an ethos of strong legal enforcement, which effectively imposes extensive investor protection laws to improve corporate governance (Defond and Hung, 2004). Where effective, this regulatory environment alleviates agency problems through enforcing informational transparency and accountability, thereby encouraging more efficient capital formation and allocation, and promoting corporate value (Walker, Zhang and Ni, 2019). Further, a well-developed system of national governance promotes the principles of voice and accountability, which give stakeholders the right to express criticisms of corporate insiders and hold them accountable by using their powers of freedom of speech, free association and access to free media. These rights also ensure that management decisions are held up to public scrutiny, empowering investors, market-makers and other stakeholders to reach judgements on company prospects. The foregoing discussions support the argument that a system of national governance influences the prevailing business ethos, which may, in turn, impact on managerial decisions at the corporate level (Kwok and Tadesse, 2006).

Common law countries, as we have contended, embrace laissez-faire market principles that deter

centralized intervention in economies, having a judiciary largely independent of government control and governance systems that encourage wealth creation and informational transparency. Albeit governments offer support to RE development in the form of subsidies or tax incentives, these may be summarily curtailed or withdrawn in response to political expediency. Investment banks and corporate funds, responsible for returning profits to their investors, will be loath to advance capital to unsubsidized, high-risk RE companies, preferring to fund value-creating projects elsewhere. Such market-based judgements are well founded on pragmatic commercial reasoning and so an overarching system of country-level governance is unlikely to exert a supplementary influence on fund providers' decisions.

Within this system, the self-same market precepts are embedded in corporate culture, constraining managers to invest in wealth-creating projects and rendering them averse to RE investments that do not offer returns in a time-frame that matches the demands of their investors. Their antipathy towards projects of uncertain worth is reinforced by an overarching system of country-level governance, which embodies the fundamental business precepts that they instinctively apply. It is the macro-level strictures imposed by country-level governance that create and regulate the financial environment in which managers work, and which will limit a propensity to make suboptimal investment decisions. Should they do so, informational transparency facilitated by country-level governance will expose them to public accountability, while the laws and regulation that such systems embody will impose sanctions that act as deterrents to transgressors. It is therefore logical to conjecture that this overarching influence is likely to augment firms' investment Q sensitivity.

Civil law countries, in contrast, exert a stronger degree of centralized control and privilege a stakeholder perspective, encouraging the adoption of CSR principles and social wealth creation, with the enforcement of laws and accountability favouring the development of sustainable sources of energy.[3] The ideals of social welfare appear to pervade society at every level, encouraging governments to subsidize RE investment (Sovacool, 2017), banks to provide investment finance (Cheng, Ioannou and Serafeim, 2013), firms to engage in RE projects and society in general to look benignly on these societal aspirations. Therefore, it is logical to propose that a system of country-level governance in a civil law jurisdiction will encourage the financing of companies investing in RE developments, arguably reducing their financial constraints.

Within this ethos, the primacy of the stakeholder perspective, underpinned by cooperative business and institutional attitudes (Strand, Freeman and Hockerts, 2015), promotes sustainability and ESG principles. This suggests that values supportive of RE development in civil law countries are internalized by governments, institutions, commerce and citizens alike. In this universal culture, such precepts are as deeply rooted in business consciousness as they are in the regulatory environment, so that macro-level strictures may exert only a marginal influence on micro-level behaviour. It therefore follows that country-level governance is likely to have a minimal impact on firms' investment Q sensitivity.

To assess the validity of these arguments, we adopt as independent variables the World Bank Worldwide Governance Indicators: regulatory quality; rule of law; voice and accountability, and evaluate their impacts by means of their interaction with cash flow and Tobin's Q. Based on the foregoing discussions, we derive our third set of hypotheses:

*H3a*: The joint effect of national governance and cash flow in reducing financing constraints in investment is more pronounced for renewable energy firms in a civil law system than for their counterparts in a common law system.

*H3b*: The joint effect of national governance and growth opportunities, viz Tobin's Q, in increasing investment sensitivity to prospects of growth opportunities is more pronounced for renewable

[3] In Scandinavian countries, the laws against environmental pollution are strong. The Environmental Code, promulgated in Sweden in 1999, has the objective of promoting '…sustainable development which will ensure a healthy and sound environment for present and future generations' (Swedish Environmental Protection Agency, 1999). In Norway, the government controls industrial polluters by granting emission allowances imposing limits on volumes of discharge (Green House Gas Emission Trading Act, 2004). Contrast this with the situation in the UK, where the government has been taken to court repeatedly for '…failing to produce an adequate National Plan to reduce $NO_2$ pollution' (Environmental Protection UK, 2019).

energy firms in a civil law system than for their counterparts in a common law system.

## Methodological issues

*Data and sample*

We obtain financial data of companies listed on stock markets globally from Datastream and country-level governance data from the Worldwide Governance Indicator (WGI) of the World Bank. The World Bank provides annual GDP and gross national income (GNI) data series. Our sample ranges from 2000 to 2017, commencing at 2000 because renewable energy development was in its early stages before then, and the number of renewable energy firms trading was too low to enable meaningful comparison. Datastream classifies the energy sector into 'alternative energy sources', covering solar, wind and biomass, and 'traditional energy sources', covering electricity, oil and gas, and multi-utilities producers. We use the terms 'alternative energy sources', as defined by Datastream, to delineate renewable energy firms whose *primary* operation is the generation of renewable energy from solar, wind or biomass sources. For conventional energy firms, we include those that generate electricity. As is well known, other energy sectors, such as oil, gas and multi-utilities producers, operate primarily in the USA and UK, while firms that produce coal are predominantly in China and India. For representativeness of our sample, we include firms that generate electricity in the traditional energy group.

Our initial sample comprises 405 RE firms from 20 countries, and 687 TE firms from 42 countries worldwide. We restrict each firm to the country of its registration to eliminate the noise of heterogeneity caused by the legal system and country-level governance prevailing in different markets, and therefore remove the firms with a cross-listing status. Further, financial information of all the firms is winsorized at the 1% level to eliminate significant outliers. After controlling for missing values, the effective sample size for the analyses consists of 236 TE firms from 20 countries, with 1,665 firm-year observations. The sample, from the electricity sector, consists of 429 firms across 42 countries, with 4,854 observations. The distribution of the firms across countries is presented in Table 1.

Table 1 shows that the USA has the greatest number of RE firms, hosting 87 and accounting

*Table 1. Sample distribution across countries*

Panel A: Renewable energy firms

| | Firms | | Observations | |
|---|---|---|---|---|
| Country | N | % | N | % |
| Australia | 17 | 7.20 | 154 | 9.25 |
| Canada | 11 | 4.66 | 100 | 6.01 |
| China | 22 | 9.32 | 176 | 10.57 |
| Denmark | 1 | 0.42 | 17 | 1.02 |
| France | 6 | 2.54 | 27 | 1.62 |
| Germany | 22 | 9.32 | 207 | 12.43 |
| Hong Kong | 14 | 5.93 | 131 | 7.87 |
| India | 9 | 3.81 | 39 | 2.34 |
| Israel | 2 | 0.85 | 15 | 0.90 |
| Italy | 2 | 0.85 | 6 | 0.36 |
| Japan | 2 | 0.85 | 21 | 1.26 |
| New Zealand | 1 | 0.42 | 10 | 0.60 |
| Norway | 3 | 1.27 | 18 | 1.08 |
| Singapore | 1 | 0.42 | 6 | 0.36 |
| South Korea | 7 | 2.97 | 63 | 3.78 |
| Spain | 5 | 2.12 | 45 | 2.70 |
| Sweden | 8 | 3.39 | 35 | 2.10 |
| Thailand | 4 | 1.69 | 23 | 1.38 |
| UK | 12 | 5.08 | 103 | 6.19 |
| USA | 87 | 36.86 | 469 | 28.17 |
| **Total** | **236** | **100** | **1,665** | **100** |

Panel B: Traditional energy (electricity) firms

| | Firms | | Observations | |
|---|---|---|---|---|
| Country | N | % | N | % |
| Argentina | 8 | 1.86 | 92 | 1.90 |
| Australia | 19 | 4.43 | 199 | 4.10 |
| Austria | 2 | 0.47 | 26 | 0.54 |
| Bangladesh | 8 | 1.86 | 44 | 0.91 |
| Belgium | 3 | 0.70 | 29 | 0.60 |
| Brazil | 31 | 7.23 | 333 | 6.86 |
| Canada | 20 | 4.66 | 222 | 4.57 |
| Chile | 13 | 3.03 | 183 | 3.77 |
| China | 69 | 16.08 | 946 | 19.49 |
| Colombia | 5 | 1.17 | 40 | 0.82 |
| Denmark | 1 | 0.23 | 15 | 0.31 |
| Finland | 1 | 0.23 | 17 | 0.35 |
| France | 10 | 2.33 | 129 | 2.66 |
| Germany | 6 | 1.40 | 94 | 1.94 |
| Greece | 4 | 0.93 | 32 | 0.66 |
| Hong Kong | 12 | 2.80 | 148 | 3.05 |
| India | 34 | 7.93 | 323 | 6.65 |
| Indonesia | 4 | 0.93 | 12 | 0.25 |
| Israel | 2 | 0.47 | 18 | 0.37 |
| Italy | 12 | 2.80 | 144 | 2.97 |
| Japan | 12 | 2.80 | 184 | 3.79 |
| Jordan | 2 | 0.47 | 28 | 0.58 |
| Kenya | 2 | 0.47 | 23 | 0.47 |
| Luxembourg | 1 | 0.23 | 10 | 0.21 |
| Malaysia | 3 | 0.70 | 50 | 1.03 |
| New Zealand | 7 | 1.63 | 41 | 0.84 |
| Norway | 1 | 0.23 | 17 | 0.35 |

(*Continued*)

*Table 1. Continued*

Panel B: Traditional energy (electricity) firms

| | Firms | | Observations | |
|---|---|---|---|---|
| Country | N | % | N | % |
| Pakistan | 15 | 3.50 | 118 | 2.43 |
| Peru | 7 | 1.63 | 69 | 1.42 |
| Philippines | 8 | 1.86 | 108 | 2.22 |
| Portugal | 2 | 0.47 | 28 | 0.58 |
| Singapore | 2 | 0.47 | 16 | 0.33 |
| South Korea | 3 | 0.70 | 37 | 0.76 |
| Spain | 7 | 1.63 | 79 | 1.63 |
| Sri Lanka | 3 | 0.70 | 29 | 0.60 |
| Sweden | 3 | 0.70 | 21 | 0.43 |
| Switzerland | 8 | 1.86 | 96 | 1.98 |
| Thailand | 16 | 3.73 | 116 | 2.39 |
| Turkey | 7 | 1.63 | 64 | 1.32 |
| UK | 9 | 2.10 | 74 | 1.52 |
| USA | 46 | 10.72 | 588 | 12.11 |
| Venezuela | 1 | 0.23 | 12 | 0.25 |
| **Total** | **429** | **100** | **4,854** | **100** |

for 36.86% of the full sample. Germany and China are ranked second, with 22 firms each, while Australia has 17 and the UK has 12. Advanced economies have more RE firms than emerging markets, although countries such as India and Brazil have made unprecedently large RE investments in the last 2 years, becoming the leading investors among developing countries (Bloomberg, 2018), albeit having many fewer active RE firms. This disparate pattern between the two groups is largely attributable to the fact that emerging markets have less developed financial systems and poorer infrastructure, as well as lacking skills and social awareness.

A fundamental premise of our argument is that renewable energy development is influenced by the nature of a legal regime whose precepts constrain the decisions of governments, banks, investors and other stakeholders. To examine this relationship, we classify countries depending on whether they have a common law regime or a civil law regime. La Porta *et al.* (1997, 1998) suggest that there are several subgroups displaying the common characteristics of civil law jurisdictions. These are, specifically, of German, French and Scandinavian origin, and what are classified as the socialist system, but which is subsumed into the civil law tradition for want of adequate data (La Porta, Lopez-de-Silanes and Shleifer, 2008). Although these branches follow similar basic principles, there are clear differences between them, which can have a significant impact on the underlying relationship. We note, in particular, that the Scandinavian countries have a stronger centralized system of civil law than others in our sample; apart from China, which is a command economy that has recently begun to adopt market principles. Thus, following Liang and Renneboog (2017) and La Porta, Lopez-de-Silanes and Shleifer (2008), we classify legal traditions within the civil law system into four divisions: *French* origin, *German* origin, *Scandinavian* origin and what we term the *Chinese civil law* system, to account for regime heterogeneity and possible influence on the trajectory of RE investment (see Table 2 for details).

### *Empirical models*

Sustainable investment in RE is the primary force driving sector development. RE firms need finance to fund investment in order to survive and grow. Finance theories posit that firms' investment expenditure may be constrained by a lack of internally generated funds when information asymmetry occurs. The pecking order hypothesis supports a model of the hierarchy of financing, which asserts that cash flow is an important determinant of a firm's fixed investment, and that asymmetric information is considerably greater for new, high-risk firms than for stable, mature firms that offer safer fixed investments. Consequently, the cost of

*Table 2. Legal origin of the countries in the study*

| Legal system | | Sample countries |
|---|---|---|
| Common law countries | | Australia, Canada, Hong Kong, India, Israel, New Zealand, Singapore, Thailand, UK, USA |
| Civil law countries | Scandinavian origin | Denmark, Norway, Sweden |
| | French origin | France, Italy, Spain |
| | German origin | Germany, Japan, South Korea |
| | Chinese origin | China |

*Sources:* La Porta *et al.* (1997); Liang and Renneboog (2017).

external funds will necessarily be higher for RE investment than for TE investment. Fazzari, Hubbard and Petersen (1988), among many others, show that constrained firms are sensitive to internal cash flow while unconstrained firms are not, and consider higher investment cash flow sensitivities as evidence of greater financing constraints (e.g. Bond *et al.*, 2003; Cho, 1995; Mairesse, Hall and Mulkay, 1999). Many studies contend that cash flow represents potential sensitivity of investment to fluctuations in available internal finance, after investment opportunities are controlled for (Carpenter, 2005; Fazzari, Hubbard and Petersen, 1988). We therefore use cash flow from operations, $CF_{i,t}$, as a proxy for financial constraints.

The empirical literature argues that a firm's financial structure provides robust and quantitatively important explanatory variables for investment at the firm level (Gilchrist and Himmelberg, 1995). To take account of the firm's financial structure in the investment cash flow sensitivity relationship, we explicitly incorporate variables representing the financial structure into the model, namely cash holdings, $Cash_{i,t}$, and total debt level, $Lever_{i,t}$. Further, to account for country-specific economic conditions, two macroeconomic variables, the annual growth rate of GDP, Dgdp, and the log of GNI per capita, lngniper, of each country are added to the regression. The growth rate of GDP indicates that better economic conditions may stimulate investments. GNI per capita reflects state income levels, since higher income levels may offer fertile ground for the government or other institutions to support a new industry in a marginal sector. The two measures capture wealth effects from the differing perspectives of individual countries, reflecting the predisposition of their citizens to support the sustainability agenda[4] (Liang and Renneboog, 2017), and also the level of protections afforded to shareholders and creditors (La Porta, Lopez-de-Silanes and Shleifer, 2008).

To estimate the hypothesized relationships, we adapt the investment function in the reduced form (Carpenter, 2005; Devereux and Schiantarelli, 1989; Fazzari, Hubbard and Peterson, 1988). The baseline cash flow investment model is specified below:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \beta_1 \left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + f\left(\frac{X_{i,t}}{K_{i,t-1}}\right) + g(M_{i,t}) + \varepsilon_{i,t} \quad (1)$$

where $I_{i,t}$ represents firm i's investment in fixed assets in year t; $CF_{i,t}$ is firm i's internal cash flow in year t; $X_{i,t}$ is a vector of firm characteristics comprising firm i's capital structure, represented by cash holding and total debt, and firm size; and $\varepsilon_{i,t}$ is an errorerm. To reduce heteroscedasticity, the financial variables are scaled by the book value of total assets at the beginning of the period, $K_{i,t-1}$. $M_{i,t}$ is a vector of macroeconomic variables, including annual growth rate of GDP, Dgdp, and log GNI per capita, lngniper, in each country.

*Q investment model.* The finance literature is consistent in the view that firm investment is market-driven behaviour and should be responsive to growth opportunities (Fazzari, Hubbard and Petersen, 1988). The Q-investment model has been used extensively in empirical studies of the relationship between corporate investment and firm growth. Tobin's Q assesses the market valuation of a company's capital compared to the replacement cost of the underlying assets, and is often used as a proxy to represent firms' future investment opportunities (Bolton, Chen and Wang, 2011; Fazzari, Hubbard and Petersen, 2000; Gilchrist and Himmelberg, 1995; Summers *et al.*, 1981). Despite the recognized difficulties in empirically implementing the Q ratio (Blanchard and Fischer, 1990), Q is a forward-looking variable capturing the ramifications of financial market frictions that impinge on the firm in all its decisions (Chirinko, 1993). We extend the investment function by including Tobin's Q to account for future investment opportunities. The investment equation is thus specified below:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \beta_1 \left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 Q_{i,t} + f\left(\frac{X_{i,t}}{K_{i,t-1}}\right) + g(M_{i,t}) + \varepsilon_{i,t} \quad (2)$$

where $Q_{i,t}$ is Tobin's Q, which is measured by the ratio of a firm's market capitalization and total liabilities over total assets at the beginning of year t.

*Extended cash flow investment model: the role of a legal system.* Finance theories propose that the

[4]Laing and Renneboog (2017) argue that people living in rich countries, with high individual incomes, are more likely to support a sustainability agenda; whereas people living in poorer countries, with low individual incomes, will be more concerned with their '. . . daily economic survival'.

financial system determines a firm's access to financial resources and hence its investment decisions (Hoshi, Kashyap and Scharfstein, 1991). The legal origin of a country can potentially affect the firm's investment decision, subject to its financial state (H1) and its expectations of the prospects of growth (H2). To test the hypotheses, we incorporate the legal origin of the country where a firm operates by means of an interaction between legal origin and cash flow, $\text{English}_i \times \text{CF}_{i,t}$, into Eq. (3); and an interaction between legal origin and Tobin's Q, $\text{English}_i \times \text{Q}_{i,t}$, into Eq. (4). The augmented investment equations are thus specified below:

$$\left(\frac{\text{I}_{i,t}}{\text{K}_{i,t-1}}\right) = \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{K}_{i,t-1}}\right) + \beta_2 \text{Q}_{i,t} + \beta_3 \text{English}_i \times \left(\frac{\text{CF}_{i,t}}{\text{K}_{i,t-1}}\right) + \text{f}\left(\frac{\text{X}_{i,t}}{\text{K}_{i,t-1}}\right) + \text{g}(\text{M}_{i,t}) + \varepsilon_{i,t} \quad (3)$$

$$\left(\frac{\text{I}_{i,t}}{\text{K}_{i,t-1}}\right) = \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{K}_{i,t-1}}\right) + \beta_2 \text{Q}_{i,t} + \beta_4 \text{English}_i \times \text{Q}_{i,t} + \text{f}\left(\frac{\text{X}_{i,t}}{\text{K}_{i,t-1}}\right) + \text{g}(\text{M}_{i,t}) + \varepsilon_{i,t} \quad (4)$$

where legal origin, $\text{English}_i$, is equal to one if firm i is registered in a common law country, or zero otherwise. Equations (3) and (4) will be examined using the full sample with the interactions of the common law system and each of the four sub-civil law systems with cash flow and Tobin's Q, respectively. We expect that $\beta_3$ in Eq. (3) and $\beta_4$ in Eq. (4) will be positive, if H1 and H2 are supported.

*Extended cash flow investment model: the role of national governance.* Next, to test for the impact of national governance, we use three country-level governance variables to measure the influence of enforcement and accountability on market forces and social preferences that determine levels of RE investment. The World Bank maintains a database of Worldwide Governance Indicators, which measure governance characteristics exhibited by different countries. We adopt the method after Liang and Renneboog (2017), and consider three variables: regulatory quality; rule of law; voice and accountability, because of their relevance to the governance characteristics exhibited by the legal systems that we examine for the purpose of this study. Regulatory quality measures the ability of a government's policies and regulations to stimulate the development of the private sector and how the attributes of the former might differ between the laissez-faire market systems of common law countries and the centralized and bureaucratic systems of civil law countries. Rule of law determines, inter alia, the degree to which actors have confidence in, and conform to, the quality of contract enforcement, property rights and the authority of the courts, and discriminates between the adversarial nature of legal systems in common law countries and the inquisitorial nature of legal systems in civil law countries (La Porta, Lopez-de-Silanes and Shleifer, 2008). Voice and accountability captures the perception of the rights of a nation's citizens to take part in elections, exercise freedom of expression, freely associate at a societal level and have access to an objective media in different legal regimes.

Arguably, our sample incorporates the influence of two significantly divergent legal systems, represented, on the one hand, by a common law system's laissez-faire, market-led entrepreneurship and, on the other hand, by China's distinctive brand of command economy capitalism. The differences between these two systems, standing at either end of a continuum of countries that fall within these two extremes, suggests significant disparities between systems of national governance practices that may give rise to distinctive investment behaviours. A system of governance is characterized by the nature of the regulation imposed, the strength and impartiality of the law that enforces it, and the ability of citizens to intervene in the process by democratic means. Accountability and enforcement, represented by regulatory quality, rule of law, and voice and accountability, effectively measure the propensity of government to intervene in society and the behaviour of its economic agents. To assess the varying effects of country-level governance, we interact the three country-level governance variables with cash flow, $\text{GV}_i \times \text{CF}_{i,t}$, and Tobin's Q, $\text{GV}_i \times \text{Q}_{i,t}$, and test for a possible joint effect for each of the five legal regimes, in the investment functions below:

$$\left(\frac{\text{I}_{i,t}}{\text{K}_{i,t-1}}\right) = \beta_1 \left(\frac{\text{CF}_{i,t}}{\text{K}_{i,t-1}}\right) + \beta_2 \text{Q}_{i,t} + \beta_5 \text{GV}_i \times \left(\frac{\text{CF}_{i,t}}{\text{K}_{i,t-1}}\right) + \text{f}\left(\frac{\text{X}_{i,t}}{\text{K}_{i,t-1}}\right)$$

$$+ g(M_{i,t}) + \varepsilon_{i,t} \quad (5)$$

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right) = \beta_1 \left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \beta_2 Q_{i,t} + \beta_6 GV_i \times Q_{i,t} + f\left(\frac{X_{i,t}}{K_{i,t-1}}\right) + g(M_{i,t}) + \varepsilon_{i,t} \quad (6)$$

where $GV_i$ represents three country-level governance variables, namely regulatory quality (Reg_q), rule of law (Rule_l), and voice and accountability (V&A). Equations (5) and (6) will be examined using the common law sample and four civil law sub-samples. We expect that $\beta_5$ in Eq. (5) and $\beta_6$ in Eq. (6) will be positive, if H3a and H3b are supported.

We adopt the ordinary least squares (OLS) model in performing the estimations to assess the validity of the three hypotheses. First, we test H1 and H2 in the baseline regressions. Second, we expand the thesis with reference to the extent to which the legal system prevailing in a jurisdiction influences an RE firm's investment decision. Third, we determine the effect of national governance on firm investment by interacting the three national governance measures with cash flow and Tobin's Q, respectively. Finally, to ensure the robustness of the results and to address endogeneity, we perform a check using generalized method of moments (GMM) estimations.

To account for the dependence of observations within a firm over time, robust standard errors will be estimated and clustered at the firm level (Arellano, 1987; White, 1980). Further, we conduct diagnostic tests on multicollinearity in our regressions. The presence of multicollinearity among independent variables can inflate standard errors, which may result in less efficient parameter estimates. To assess this possibility, we conduct two tests of multicollinearity. First, we check correlations among the independent variables using the Pearson correlation test (see Table A1 in the Supporting Information). The values range between 0.01 and 0.67, with none exceeding the 0.80 threshold. Second, we conduct a variance inflation factor (VIF) test (see Table A2 in the Supporting Information). The values range between 1.27 and 6.00, and none is above the VIF threshold of 10 (O'Brien, 2007), with an average VIF of 3.68. These two tests justify our confidence in the fact that multicollinearity is not a problem in our regressions.

Table 3 provides detailed definitions of the variables, including firm-level investment and financial condition, legal system variables, national governance measurements and macroeconomic variables.

### *Summary of statistics*

Table 4 reports descriptive statistics of our samples for the regression analyses, which show distinctive differences in both RE and TE investment across the legal systems. With respect to the renewable energy sector, Panel A shows that the median value of the RE investment ratio is 3.36% for the full sample. The median investment ratio of the civil law system is 4.51%, significantly higher than the median in common law systems, which is 2.71%. This clearly indicates that investment in RE in civil law countries is proportionately twice as high as investment in common law countries. Within the civil law systems, China has the highest investment ratio of all (7.56%), followed by German countries (4.22%), French countries (3.56%) and Scandinavian countries (3.32%). It must be noted, however, that China's RE investment levels have been significantly augmented by surges in investment since 2015 (Zhang *et al.*, 2016). With respect to the traditional energy sector, Panel B shows that the median value of the TE investment ratio is 5.69% for the full sample. Common law countries have a relatively higher median investment ratio (6.09%) than civil law countries (5.40%). Within civil law systems, China has made by far the greatest investment at 7.54%, compared to investment in French countries (4.91%), German countries (4.79%) and Scandinavian countries (3.41%).

Overall, TE investment remains higher than RE investment across all legal systems, and the biggest difference is observed in English legal system countries, with 6.09% (TE) as opposed to 2.71% (RE). Civil law systems display lower differences, with Scandinavia standing at 3.41% (TE) to 3.32% (RE); French countries at 4.91% (TE) to 3.56% (RE); German countries at 4.79% (TE) to 4.22% (RE); and China at 7.54% (TE) to 7.56% (RE). Clearly, English legal system countries' investment in RE is less than half their investment in TE. Conversely, civil law countries in general are approaching, or have reached, a rough balance between investment in RE and TE sources.

*Table 3. Variable definitions*

| Measure | Variable | Definition |
|---|---|---|
| Investment | I | Capital expenditures/total assets at the beginning of the period |
| Total assets | K | Book value of total assets |
| Growth prospects | Q | Tobin's Q: (market capitalization + total liabilities)/total assets at the beginning of the period |
| Cash flow | CF | Net cash flow operating activities/total assets at the beginning of the period |
| Cash holding | Cash | Cash & equivalents generic/total assets at the beginning of the period |
| Total debt | Lever | Total liabilities/total assets at the beginning of the period |
| Total sales | Sale | Operating income/total assets at the beginning of the period |
| Return on equity | ROE | Net income/shareholder's equity |
| Firm size | Size | Log (total assets + 1) |
| GDP growth rate | Ggdp | Annual percentage growth rate of GDP at market prices based on constant local currency (aggregates are based on constant 2010 US dollars) |
| GNI per capital | lngniper | Log (GNI per capita) (PPP, current international $, US dollars) |
| Legal system | English | English origin: a dummy variable takes the value of 1 if the firm is registered in a common law country, and 0 otherwise |
| | Scandinavian | Scandinavian origin: a dummy variable takes the value of 1 if the firm is registered in a Scandinavian civil law country, and 0 otherwise |
| | French | French origin: a dummy variable takes the value of 1 if the firm is registered in a French civil law country, and 0 otherwise |
| | German | German origin: a dummy variable takes the value of 1 if the firm is registered in a German civil law country, and 0 otherwise |
| | China | Chinese origin: a dummy variable takes the value of 1 if the firm is registered in a Chinese civil law country, and 0 otherwise |
| **National governance** | | |
| Regulatory quality | Reg_q | Regulatory quality measures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private-sector development. Estimates give the country's score on the aggregate indicator, in units of a standard normal distribution (i.e. ranging from approximately −2.5 to 2.5). |
| Rule of law | Rule_l | Rule of law measures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police and the courts, as well as the likelihood of crime and violence. Estimates give the country's score on the aggregate indicator, in units of a standard normal distribution (i.e. ranging from approximately −2.5 to 2.5). |
| Voice and accountability | V&A | Voice and accountability measures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association and a free media. Estimates give the country's score on the aggregate indicator, in units of a standard normal distribution (i.e. ranging from approximately −2.5 to 2.5). |

*Notes:* Firm-level financial data are obtained from Datastream; national governance data are obtained from the World Bank Worldwide Governance Indicators.

Scandinavian countries' investment in the two energy sources almost match, while German countries are also approaching parity between the two sources, with French countries appearing to lag behind. Most interesting amongst these statistics, though, is that China dominates in both RE and TE investment, virtually reaching par.

In respect of financial attributes, RE and TE firms display distinctive differences. RE firms have negative cash flow (−3.57%), negative sales (−2.92%), negative ROE (−7.31%) and a much lower debt level (44.96%) in comparison to TE firms (60.98%), while having a similar Q ratio of 1.39 (RE) to 1.13 (TE). Further, RE firms are much smaller in size (12.22%) in comparison to TE firms (15.86%). These statistics are clear evidence that RE firms are loss-making, have worse financial conditions and receive much less external debt finance compared to their peers in the TE sector.

In respect of national governance, quality in common law systems appears to be higher than in civil law systems, based on the three governance measures. However, closer scrutiny of the subgroup figures reveals that the lower scores for the civil law group are generated wholly by China's contribution, which is negative across all three

*Table 4. Summary of statistics*

Panel A: Renewable energy sector

| Variables | N | Mean | Median | Min | Max | SD |
|---|---|---|---|---|---|---|
| I (%) | 1,665 | 9.7545 | 3.3641 | 0.0000 | 114.4341 | 18.0046 |
| English | 1,665 | 0.6306 | 1.0000 | 0.0000 | 1.0000 | 0.4828 |
| Scandinavian | 1,665 | 0.0420 | 0.0000 | 0.0000 | 1.0000 | 0.2007 |
| French | 1,665 | 0.0468 | 0.0000 | 0.0000 | 1.0000 | 0.2114 |
| German | 1,665 | 0.1748 | 0.0000 | 0.0000 | 1.0000 | 0.3799 |
| China | 1,665 | 0.1057 | 0.0000 | 0.0000 | 1.0000 | 0.3076 |
| Q | 1,665 | 3.2546 | 1.3918 | 0.3808 | 76.1120 | 8.1244 |
| CF (%) | 1,665 | −8.4578 | −3.5752 | −43.5730 | 48.1389 | 20.5520 |
| Cash (%) | 1,665 | 36.6961 | 19.5615 | 0.0098 | 253.8272 | 52.5078 |
| Lever (%) | 1,665 | 45.4386 | 44.9585 | 9.2836 | 101.7318 | 26.1742 |
| Sale (%) | 1,665 | −29.8732 | −2.9231 | −797.6190 | 50.5407 | 106.5097 |
| ROE (%) | 1,665 | −44.1630 | −7.3100 | −369.7700 | 81.0800 | 94.4872 |
| Size | 1,665 | 12.4046 | 12.2175 | 3.4965 | 23.0374 | 3.2676 |
| Ggdp (%) | 1,665 | 2.7590 | 2.4511 | −5.6189 | 15.2404 | 2.8281 |
| lngniper | 1,665 | 10.4673 | 10.6310 | 7.6686 | 11.2018 | 0.5778 |

**Median difference tests on investment**

| I (%) | Common law system | Civil law system | Scandinavian | French | German | China |
|---|---|---|---|---|---|---|
| N | 1,050 | 615 | 70 | 78 | 291 | 176 |
| Median | 2.7087 | 4.5066 | 3.3183 | 3.5598 | 4.2232 | 7.5622 |
| Median test | −1.7979*** | −0.6096 | −0.8511** | −1.5145** | −4.8535*** | |

**National governance (median)**

| | Common law system | Civil law system | Scandinavian | French | German | China |
|---|---|---|---|---|---|---|
| Reg_q | 1.6078 | 1.1571 | 1.7984 | 1.0703 | 1.5361 | −0.2645 |
| | (0.4842) | (0.7984) | (0.1570) | (0.1761) | (0.2785) | (0. 0591) |
| Rule_l | 1.6381 | 1.4131 | 1.9660 | 1.1683 | 1.6392 | −0.4145 |
| | (0.4274) | (0.9397) | (0.0514) | (0.3046) | (0.2921) | (0.0954) |
| V&A | 1.1336 | 1.1355 | 1.5768 | 1.1225 | 1.3368 | −1.6314 |
| | (0.4313) | (1.3209) | (0.0693) | (0.0808) | (0.2862) | (0.0660) |

Panel B: Traditional energy sector (electricity)

| Variables | N | Mean | Median | Min | Max | SD |
|---|---|---|---|---|---|---|
| I (%) | 4,854 | 9.2336 | 5.6941 | 0.0000 | 114.4341 | 14.1332 |
| English | 4,854 | 0.4139 | 0.0000 | 0.0000 | 1.0000 | 0.4926 |
| Scandinavian | 4,854 | 0.0144 | 0.0000 | 0.0000 | 1.0000 | 0.1192 |
| French | 4,854 | 0.2868 | 0.0000 | 0.0000 | 1.0000 | 0.4523 |
| German | 4,854 | 0.0900 | 0.0000 | 0.0000 | 1.0000 | 0.2863 |
| China | 4,854 | 0.1949 | 0.0000 | 0.0000 | 1.0000 | 0.3962 |
| Q | 4,854 | 1.4106 | 1.1302 | 0.3808 | 76.1120 | 2.2385 |
| CF (%) | 4,854 | 6.4128 | 7.0742 | −43.5730 | 48.1389 | 10.7966 |
| Cash (%) | 4,854 | 12.7151 | 6.1358 | 0.0098 | 253.8272 | 25.5079 |
| Lever (%) | 4,854 | 56.8393 | 60.9831 | 9.2836 | 101.7318 | 20.8121 |
| Sale (%) | 4,854 | 2.6298 | 4.9974 | −797.6190 | 50.5407 | 33.1812 |
| ROE (%) | 4,854 | 2.5755 | 8.2800 | −369.7700 | 81.0800 | 40.7566 |
| Size | 4,854 | 15.8584 | 15.8613 | 3.5553 | 23.0374 | 3.0201 |
| Ggdp (%) | 4,854 | 4.1639 | 3.2651 | −10.8945 | 18.2866 | 3.7454 |
| lngniper | 4,854 | 9.8126 | 9.8658 | 7.5909 | 11.4139 | 0.8803 |

(*Continued*)

*Table 4. Continued*

| Median difference tests on investment | | | | | | |
|---|---|---|---|---|---|---|
| I (%) | Common law system | Civil law system | Scandinavian | French | German | China |
| N | 2,009 | 2,845 | 70 | 1,392 | 437 | 946 |
| Median | 6.0873 | 5.3963 | 3.4148 | 4.9122 | 4.7897 | 7.5363 |
| Median test | 0.6910 | 2.6725*** | 1.1751*** | 1.2976*** | −1.4490*** | |
| **National governance (median)** | | | | | | |
| | Common law system | Civil law system | Scandinavian | French | German | China |
| Reg_q | 1.4929 | 0.0939 | 1.8034 | 0.3995 | 1.4281 | −0.2408 |
| | (0.9613) | (0. 7525) | (0.1732) | (0.6731) | (0.3049) | (0.0835) |
| Rule_l | 1.5961 | −0.2318 | 1.9606 | 0.0441 | 1.6015 | −0.4648 |
| | (0.9303) | (0.8949) | (0.0492) | (0.7719) | (0.2883) | (0.0967) |
| V&A | 1.0972 | 0.4505 | 1.5716 | 0.5371 | 1.1096 | −1.6314 |
| | (0.7510) | (1.2229) | (0.0792) | (0.5257) | (0.2741) | (0.0831) |

*Notes:* Financial data have been winsorized at the 1% level to remove outliers. The standard deviations of national governance measures are in brackets. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

measures. When discounting China, Scandinavia's score becomes the highest of all the groups, which accords with the findings of Liang and Renneboog (2017). We note also that German legal origin countries score higher than French legal origin countries. Both energy groups follow the same trends, and it transpires that governance standards are much higher in RE firms because they operate mainly in countries with higher ratings than those countries where TE firms trade.

## Empirical results and discussions

Table 5 reports the baseline regression results of RE investment. Table 6 presents the results of TE investment. Table 7 presents the joint effect of country-level governance with cash flow on investment. Table 8 presents the joint effect of country-level governance with Tobin's Q on investment. Table 9 presents the results of RE investment, excluding investment in China, and Table 10 presents GMM results, for robustness.

### *Baseline regressions*

Table 5 show that the five investment models produce generally expected results. The coefficients on Tobin's Q are positive, although insignificant in most cases. As expected, cash holdings have a positive impact on RE investment in all regressions, indicating that a higher level of cash holding increases investment, which is consistent with the pecking-order hypothesis that firms prefer to invest using internal funds. ROE and leverage are significant and positive in all cases, indicating that firms with a higher level of ROE and leverage tend to make more investments.

*Investment cash flow sensitivity.* The results of greatest interest are those generated by the interaction terms, and they generally confirm our hypotheses 1 and 2. With respect to investment cash flow sensitivity, cash flow has a positive impact on investment in common law countries (0.1072, $p < 0.10$), as Model R2 shows. This confirms H1 that RE firms in a common law system face financial constraints, supporting our argument that the risk intrinsic to RE projects increases the aversion of financial providers to such investments and hence firms' sensitivity to cash flow. This is consistent with our contention that government support in the form of subsidies and other forms of economic relief in common law countries is relatively lower, less certain and more likely to be reduced or curtailed, as echoed by Pearson and Watson (2012). When external funds cannot be a perfect substitute for internal funds, since they are available only at a high premium due to the presence of transaction costs (Myers and Majluf, 1984), dynamic RE firms face a financial gap in their investment activities and are less able to undertake RE projects to achieve the economies of scale

*Table 5. Baseline regression results: renewable energy investment*

| | Models | | | | |
|---|---|---|---|---|---|
| Variables | R1 | R2 | R3 | R4 | R5 |
| English*CF | | 0.1072* | | | |
| | | (0.0535) | | | |
| English*Q | | | 0.9322** | | |
| | | | (0.3348) | | |
| Scandinavian*CF | | | | −0.1125 | |
| | | | | (0.0773) | |
| French*CF | | | | −0.1185 | |
| | | | | (0.1016) | |
| German*CF | | | | −0.1319** | |
| | | | | (0.0494) | |
| China*CF | | | | 0.0393 | |
| | | | | (0.0537) | |
| Scandinavian*Q | | | | | −1.1150*** |
| | | | | | (0.2996) |
| French*Q | | | | | −0.6034 |
| | | | | | (0.4049) |
| German*Q | | | | | −0.9836* |
| | | | | | (0.5231) |
| China*Q | | | | | −0.7774 |
| | | | | | (0.7818) |
| Q | −0.0406 | −0.0306 | −0.9678*** | −0.0299 | −0.0351 |
| | (0.0419) | (0.0418) | (0.3090) | (0.0417) | (0.0459) |
| CF | 0.0462 | −0.0246 | 0.0469 | 0.0801 | 0.0460 |
| | (0.0494) | (0.0353) | (0.0482) | (0.0549) | (0.0496) |
| Cash | 0.0874*** | 0.0870*** | 0.0924*** | 0.0869*** | 0.0922*** |
| | (0.0112) | (0.0111) | (0.0130) | (0.0115) | (0.0130) |
| Lever | 0.0800** | 0.0783** | 0.0835** | 0.0787** | 0.0825** |
| | (0.0297) | (0.0299) | (0.0296) | (0.0301) | (0.0291) |
| Sale | −0.0392*** | −0.0405*** | −0.0381*** | −0.0404*** | −0.0381*** |
| | (0.0073) | (0.0077) | (0.0073) | (0.0077) | (0.0073) |
| ROE | 0.0191* | 0.0187* | 0.0189* | 0.0190* | 0.0186* |
| | (0.0096) | (0.0098) | (0.0095) | (0.0099) | (0.0095) |
| Size | 0.2765 | 0.2502 | 0.3181 | 0.2596 | 0.3334 |
| | (0.3192) | (0.3150) | (0.3064) | (0.3137) | (0.3211) |
| Ggdp | 0.2082 | 0.1963 | 0.2438 | 0.1664 | 0.2312 |
| | (0.2525) | (0.2530) | (0.2677) | (0.2597) | (0.3482) |
| lngniper | −0.7267 | −0.8302 | −1.1237 | −0.7947 | −0.9943 |
| | (1.3609) | (1.3209) | (1.0854) | (1.3653) | (1.1761) |
| Constant | 9.1211 | 10.7343 | 12.8747 | 10.3032 | 11.4359 |
| | (15.5766) | (15.2768) | (12.5556) | (15.7412) | (13.8250) |
| Year effect | control | control | control | control | control |
| N | 1,665 | 1,665 | 1,665 | 1,665 | 1,665 |
| $R^2$ | 0.162 | 0.165 | 0.166 | 0.166 | 0.166 |

*Notes:* This table reports the baseline regression results for testing H1 and H2. Models T1 to T5 are estimated using OLS. English is a dummy variable that denotes a system of common law legal origin. Scandinavian, French, German and China are dummy variables that denote four subgroups of a system of civil law legal origin. Robust standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Table 3.

that would increase their ability to compete in the market.

Conversely, the coefficients on cash flow for all subgroups of the civil law system are negative with different levels of significance, as Model R4 shows. RE firms in civil law countries face lower financial constraints than their counterparts in common law countries. Among the four subgroups, countries of German origin contribute most to this observed effect (−0.1319, $p < 0.05$), which is consistent

*Table 6. Regression results: traditional energy investment*

| | Models | | | | |
|---|---|---|---|---|---|
| Variables | T1 | T2 | T3 | T4 | T5 |
| English*CF | | 0.1433* | | | |
| | | (0.0808) | | | |
| English*Q | | | 0.7494** | | |
| | | | (0.3492) | | |
| Scandinavian*CF | | | | −0.8885* | |
| | | | | (0.4834) | |
| French*CF | | | | −0.1389 | |
| | | | | (0.0875) | |
| German*CF | | | | −0.2203*** | |
| | | | | (0.0720) | |
| China*CF | | | | −0.0698 | |
| | | | | (0.0953) | |
| Scandinavian*Q | | | | | −1.0317 |
| | | | | | (3.6032) |
| French*Q | | | | | −0.5566* |
| | | | | | (0.3184) |
| German*Q | | | | | −3.2336*** |
| | | | | | (0.7968) |
| China*Q | | | | | −0.8876 |
| | | | | | (0.5276) |
| Q | −0.1020 | −0.0610 | −0.5813** | −0.0619 | 0.1158 |
| | (0.1097) | (0.1148) | (0.2704) | (0.1138) | (0.2120) |
| CF | 0.0692* | 0.0023 | 0.0775* | 0.1442** | 0.0738* |
| | (0.0407) | (0.0587) | (0.0408) | (0.0605) | (0.0402) |
| Cash | 0.1977*** | 0.2020*** | 0.1985*** | 0.2018*** | 0.1992*** |
| | (0.0279) | (0.0290) | (0.0283) | (0.0289) | (0.0279) |
| Lever | 0.0982*** | 0.0971*** | 0.0976*** | 0.0960*** | 0.0977*** |
| | (0.0261) | (0.0273) | (0.0259) | (0.0277) | (0.0260) |
| Sale | 0.0081 | 0.0071 | 0.0161 | 0.0068 | 0.0147 |
| | (0.0123) | (0.0124) | (0.0141) | (0.0122) | (0.0138) |
| ROE | 0.0006 | −0.0010 | 0.0029 | −0.0007 | 0.0025 |
| | (0.0080) | (0.0081) | (0.0082) | (0.0081) | (0.0080) |
| Size | −0.2859** | −0.2982** | −0.2988** | −0.2759** | −0.2296* |
| | (0.1233) | (0.1202) | (0.1154) | (0.1226) | (0.1137) |
| Ggdp | 0.2644* | 0.2781** | 0.2870** | 0.2230 | 0.3077** |
| | (0.1440) | (0.1314) | (0.1265) | (0.1366) | (0.1194) |
| lngniper | −0.6989 | −0.7795 | −0.7445 | −0.6703 | −0.4117 |
| | (0.8909) | (0.8441) | (0.8295) | (0.8635) | (0.8228) |
| Constant | 10.5815 | 11.5482 | 11.1556 | 10.4137 | 7.3200 |
| | (8.6776) | (8.3258) | (8.1759) | (8.5159) | (8.2411) |
| Year effect | control | control | control | control | control |
| N | 4854 | 4854 | 4854 | 4854 | 4854 |
| $R^2$ | 0.133 | 0.136 | 0.136 | 0.140 | 0.140 |

*Notes:* This table reports the regression results for the traditional energy (electricity) sector following the same procedure as Table 5. Models T1 to T5 are estimated using OLS. English is a dummy variable that denotes a system of common law legal origin. Scandinavian, French, German and China are dummy variables that denote four subgroups of a system of civil law legal origin. Robust standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Table 3.

with the evidence that RE investment in German civil law countries is the highest among the civil law grouping, as reported in Panel B of Table 4. Arguably, this is due partly to fiscal support and partly to the availability of bank finance for RE development. In Germany, electricity from renewable sources is mainly supported through a market premium scheme and FiTs (RES Legal, 2017). In addition, bank-based investment supported by low interest rates predominates in the German

*Table 7. Regression results: the impact of national governance on investment-cash flow sensitivity*

| | Common law system | | | Civil law system | | |
|---|---|---|---|---|---|---|
| Variables | GC1 | GC2 | GC3 | GC1 | GC2 | GC3 |
| Reg_q*CF | 0.1278 | | | −0.1686*** | | |
| | (0.0862) | | | (0.0511) | | |
| Reg_q | 2.6191 | | | 0.8818 | | |
| | (1.7193) | | | (2.5459) | | |
| Rule_l*CF | | −0.0236 | | | −0.1228* | |
| | | (0.0918) | | | (0.0562) | |
| Rule_l | | 3.9675 | | | 0.8679 | |
| | | (4.1014) | | | (3.6918) | |
| V&A*CF | | | −0.1990 | | | −0.1098*** |
| | | | (0.1492) | | | (0.0253) |
| V&A | | | 2.1113 | | | −1.2469 |
| | | | (1.8534) | | | (1.8444) |
| Q | −0.0143 | 0.0050 | 0.0094 | −0.7184 | −0.8166 | −0.9249 |
| | (0.0396) | (0.0576) | (0.0599) | (0.5147) | (0.5406) | (0.5606) |
| CF | −0.1065 | 0.1295 | 0.3185 | 0.1370** | 0.0953 | 0.0311 |
| | (0.1133) | (0.1546) | (0.1997) | (0.0426) | (0.0623) | (0.0402) |
| Cash | 0.0874*** | 0.0857*** | 0.0836*** | 0.1073*** | 0.1068*** | 0.1090*** |
| | (0.0170) | (0.0159) | (0.0139) | (0.0224) | (0.0227) | (0.0218) |
| Lever | 0.0959** | 0.0978** | 0.0997** | 0.0658 | 0.0647 | 0.0698 |
| | (0.0379) | (0.0382) | (0.0397) | (0.0519) | (0.0512) | (0.0513) |
| Sale | −0.0405*** | −0.0411*** | −0.0410*** | −0.0455 | −0.0447 | −0.0434 |
| | (0.0086) | (0.0079) | (0.0079) | (0.0404) | (0.0412) | (0.0418) |
| ROE | 0.0160 | 0.0156 | 0.0155 | 0.0420*** | 0.0412*** | 0.0419*** |
| | (0.0121) | (0.0126) | (0.0125) | (0.0124) | (0.0123) | (0.0120) |
| Size | 0.7116* | 0.9134* | 0.9896** | 0.1625 | 0.1588 | 0.0982 |
| | (0.3640) | (0.4269) | (0.3754) | (0.2590) | (0.2594) | (0.2414) |
| Ggdp | 0.4140 | 0.4653 | 0.5890 | 0.0901 | 0.1014 | 0.1004 |
| | (0.6124) | (0.5611) | (0.5000) | (0.3785) | (0.3779) | (0.3778) |
| lngniper | −2.1484 | −2.6274 | −0.0595 | −2.8573 | −3.1338 | 0.7098 |
| | (1.5906) | (2.9387) | (0.6714) | (3.3217) | (5.2835) | (3.9809) |
| Constant | 8.4769 | 8.7121 | −13.4643 | 30.7452 | 33.7107 | −1.5339 |
| | (13.5704) | (22.5328) | (10.8481) | (31.3889) | (46.7933) | (38.9033) |
| Year effect | control | control | control | control | control | control |
| N | 955 | 955 | 955 | 546 | 546 | 546 |
| $R^2$ | 0.195 | 0.194 | 0.198 | 0.229 | 0.225 | 0.231 |

*Notes:* This table reports the regression results of the effects of national governance on the investment-cash flow relationship. Models GC1 to GC3 are estimated using OLS. Reg_q, Rule_l and V&A signify regulatory quality, rule of law, and voice and accountability, respectively. Robust standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Table 3.

jurisdiction (Kwok and Tadesse, 2006; RES Legal, 2017), as it does in other civil law countries (Allen, Carletti and Marquez, 2015; Magill, Quinzii and Rochet, 2015). As Fama (1985) maintains, the close connection between a bank and its clients gives the former access to inside information, not publicly available, which enables it to scrutinize management performance and ensure that investors' interests are being best served. Such close monitoring makes banks aware of liquidity problems at an early stage of RE project development and facilitates swift action to obviate failure and losses to investors. This organic involvement helps to reduce banks' credit risk, encouraging them to advance funds for RE projects and hence diminishing firms' sensitivity to cash flow in their investment.

*Investment Q sensitivity.* With respect to investment Q sensitivity, the coefficient on the interaction terms, $English_i \times Q_{i,t}$, is positive and significant (0.9322, $p < 0.05$), as Model R3 shows. The result supports H2, that the strong legal system in a common law jurisdiction creates a high degree of transparency, exposes managers' decisions to public scrutiny and obliges them to seek investments

*Table 8. Regression results: the impact of national governance on investment-Q sensitivity*

| | Common law system | | | Civil law system | | |
|---|---|---|---|---|---|---|
| Variables | GQ1 | GQ2 | GQ3 | GQ1 | GQ2 | GQ3 |
| Reg_q*CF | 0.2699 | | | −0.4755 | | |
| | (0.2976) | | | (0.5142) | | |
| Reg_q | 1.0779 | | | 1.1752 | | |
| | (1.7129) | | | (3.0706) | | |
| Rule_l*CF | | 0.2318 | | | −0.5022 | |
| | | (0.7721) | | | (0.4554) | |
| Rule_l | | 3.6298 | | | 0.4619 | |
| | | (3.6612) | | | (3.7688) | |
| V&A*CF | | | 0.0333 | | | −0.3117 |
| | | | (0.3348) | | | (0.3055) |
| V&A | | | 2.7383 | | | −1.3397 |
| | | | (2.1885) | | | (1.7884) |
| Q | −0.4070 | −0.3741 | −0.0333 | −0.2775 | −0.2011 | −0.6533 |
| | (0.4154) | (1.2277) | (0.3715) | (0.3388) | (0.4043) | (0.3891) |
| CF | 0.0883* | 0.0911* | 0.0903* | −0.0678 | −0.0688 | −0.0670 |
| | (0.0476) | (0.0487) | (0.0484) | (0.0602) | (0.0586) | (0.0586) |
| Cash | 0.0864*** | 0.0856*** | 0.0851*** | 0.1074*** | 0.1069*** | 0.1077*** |
| | (0.0157) | (0.0153) | (0.0149) | (0.0229) | (0.0223) | (0.0222) |
| Lever | 0.0988** | 0.0974** | 0.0960** | 0.0600 | 0.0592 | 0.0633 |
| | (0.0385) | (0.0383) | (0.0392) | (0.0473) | (0.0476) | (0.0476) |
| Sale | −0.0407*** | −0.0412*** | −0.0411*** | −0.0515 | −0.0524 | −0.0522 |
| | (0.0083) | (0.0078) | (0.0080) | (0.0411) | (0.0414) | (0.0416) |
| ROE | 0.0166 | 0.0158 | 0.0154 | 0.0360*** | 0.0356*** | 0.0362*** |
| | (0.0124) | (0.0127) | (0.0127) | (0.0099) | (0.0101) | (0.0098) |
| Size | 0.7766** | 0.9108* | 0.9805** | 0.1440 | 0.1355 | 0.0860 |
| | (0.3325) | (0.4110) | (0.3985) | (0.2919) | (0.2995) | (0.2767) |
| Ggdp | 0.4275 | 0.4601 | 0.5843 | 0.2198 | 0.2343 | 0.2056 |
| | (0.5811) | (0.5560) | (0.5322) | (0.4255) | (0.4108) | (0.4144) |
| lngniper | −1.1423 | −2.6167 | −0.4265 | −1.7645 | −0.5869 | 2.4331 |
| | (1.4439) | (2.9210) | (0.8594) | (3.8580) | (5.1496) | (3.7986) |
| Constant | 2.4851 | 9.2259 | −9.3014 | 20.2620 | 9.4444 | −18.0192 |
| | (11.7669) | (22.7399) | (12.1552) | (36.0235) | (45.3454) | (37.2776) |
| Year effect | control | control | control | control | control | control |
| N | 955 | 955 | 955 | 546 | 546 | 546 |
| $R^2$ | 0.193 | 0.194 | 0.194 | 0.214 | 0.216 | 0.216 |

*Notes:* This table reports the regression results of the effects of national governance on the investment-Q relationship. Models GQ1 to GQ3 are estimated using OLS. Reg_q, Rule_l and V&A signify regulatory quality, rule of law, and voice and accountability, respectively. Robust standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Table 3.

that promise positive returns within a reasonable term.

Our interaction analyses of the civil law subgroup countries in Model R5 generate mixed results. Notably, Tobin's Q for Scandinavia (−1.1150, $p < 0.01$) and for Germany (−0.9836, $p < 0.10$) is negative and significant. It is, however, insignificant for the French and Chinese legal systems, although both coefficients are negative, as expected. The evidence supporting H2 in respect of civil law countries is derived principally from the influence of the Scandinavian and, to a lesser extent, German legal jurisdictions. These results provide sufficient evidence to confirm our argument that RE investment in civil law countries is supported by an ethos that is conducive to social wealth creation and the fulfilment of ESG ideals. As we have argued, the system of social democracy throughout Scandinavia appears to be more interventionist than in other countries in the civil law grouping, and national policies and governance structures drive the move towards RE deployment, with municipalities and cities taking a major role in such developments. The Nordic bloc is pursuing an aggressive programme to replace fossil fuels with green sources of energy, driven by subsidization

*Table 9. Regression results: renewable energy investment excluding investment in China*

| | Models | | | | |
|---|---|---|---|---|---|
| Variables | D1 | D2 | D3 | D4 | D5 |
| English*CF | | 0.1079* | | | |
| | | (0.0561) | | | |
| English*Q | | | 0.8737* | | |
| | | | (0.4560) | | |
| Scandinavian*CF | | | | −0.0911 | |
| | | | | (0.0958) | |
| French*CF | | | | −0.1192 | |
| | | | | (0.0923) | |
| German*CF | | | | −0.1158** | |
| | | | | (0.0485) | |
| Scandinavian*Q | | | | | −1.3440*** |
| | | | | | (0.3186) |
| French*Q | | | | | 0.0997 |
| | | | | | (0.7060) |
| German*Q | | | | | −0.6564 |
| | | | | | (0.6745) |
| Q | −0.0466 | −0.0362 | −0.9182** | −0.0364 | −0.0429 |
| | (0.0415) | (0.0405) | (0.4254) | (0.0404) | (0.0430) |
| CF | 0.0326 | −0.0411 | 0.0308 | 0.0675 | 0.0280 |
| | (0.0526) | (0.0357) | (0.0523) | (0.0554) | (0.0544) |
| Cash | 0.0876*** | 0.0871*** | 0.0911*** | 0.0873*** | 0.0904*** |
| | (0.0130) | (0.0129) | (0.0144) | (0.0136) | (0.0142) |
| Lever | 0.0744** | 0.0725** | 0.0782** | 0.0722** | 0.0741** |
| | (0.0305) | (0.0309) | (0.0309) | (0.0308) | (0.0300) |
| Sale | −0.0376*** | −0.0389*** | −0.0369*** | −0.0389*** | −0.0367*** |
| | (0.0075) | (0.0078) | (0.0076) | (0.0079) | (0.0077) |
| ROE | 0.0159* | 0.0157 | 0.0155* | 0.0156 | 0.0149 |
| | (0.0089) | (0.0091) | (0.0088) | (0.0090) | (0.0086) |
| Size | 0.4263* | 0.4013 | 0.4776* | 0.4018 | 0.5049** |
| | (0.2427) | (0.2415) | (0.2301) | (0.2401) | (0.2263) |
| Ggdp | −0.0460 | −0.0580 | −0.1374 | −0.0557 | −0.1004 |
| | (0.4847) | (0.5084) | (0.4547) | (0.5074) | (0.4435) |
| lngniper | 5.4780 | 4.9387 | 4.4313 | 5.0030 | 5.7047 |
| | (3.2326) | (3.1500) | (3.6721) | (3.1702) | (4.3734) |
| Constant | −57.7959 | −51.6661 | −47.3651 | −52.3366 | −60.8548 |
| | (35.0252) | (34.2668) | (39.0101) | (34.4255) | (46.0830) |
| Year effect | control | control | control | control | control |
| N | 1,427 | 1,427 | 1,427 | 1,427 | 1,427 |
| $R^2$ | 0.175 | 0.178 | 0.178 | 0.178 | 0.179 |

*Notes:* This table reports the regression results excluding investment in China following the same procedure as Table 5. Models D1 to D5 are estimated using OLS. English is a dummy variable that denotes a system of common law legal origin. Scandinavian, French and German are dummy variables that denote three subgroups of a system of civil law legal origin. Robust standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Table 3.

(Sovacool, 2017), which is strongly suggestive of a political will to achieve carbon neutrality for the benefit of all. A benevolent social stance is also adopted in Germany, which has been described as a nation that practices 'welfare capitalism' (Dore, 2000) and fosters a corporate sector that serves a wide range of stakeholders rather than focusing primarily on shareholders' needs (Adams, 1998). The management of firms engaged in clean energy production in such stakeholder economies, where businesses and institutions contribute to the creation of a cooperative environment (Strand, Freeman and Hockerts, 2015), regard social well-being as an important factor when selecting ventures to adopt. Consequently, they are not greatly influenced by stock market prices, and are therefore less sensitive to projects' prospects than their counterparts in common law countries.

*Table 10. Dynamic GMM estimations: renewable energy investment*

| | Models | | | | |
|---|---|---|---|---|---|
| Variables | M1 | M2 | M3 | M4 | M5 |
| English*CF | | 0.0686** | | | |
| | | (0.0348) | | | |
| English*Q | | | 0.5724** | | |
| | | | (0.2456) | | |
| Scandinavian*CF | | | | −0.4101** | |
| | | | | (0.1627) | |
| French*CF | | | | −0.0711 | |
| | | | | (0.1181) | |
| German*CF | | | | −0.0539 | |
| | | | | (0.0751) | |
| China*CF | | | | 0.1389 | |
| | | | | (0.1394) | |
| Scandinavian*Q | | | | | −4.0651*** |
| | | | | | (0.9592) |
| French*Q | | | | | 3.1623 |
| | | | | | (2.3451) |
| German*Q | | | | | 0.2962 |
| | | | | | (1.0792) |
| China*Q | | | | | 0.0989 |
| | | | | | (1.0137) |
| $L.I_{i,t}$ | 0.3008*** | 0.2904*** | 0.3033*** | 0.2884*** | 0.2728*** |
| | (0.0789) | (0.0175) | (0.0106) | (0.0807) | (0.0779) |
| Q | 0.3138 | 0.3027*** | −0.2425 | 0.3043 | 0.3428 |
| | (0.2987) | (0.1116) | (0.2532) | (0.3808) | (0.3439) |
| CF | 0.0056 | −0.0339 | 0.0050 | 0.0282 | −0.0134 |
| | (0.0469) | (0.0258) | (0.0103) | (0.0572) | (0.0497) |
| Cash | 0.0485* | 0.0517*** | 0.0490*** | 0.0490* | 0.0348 |
| | (0.0270) | (0.0084) | (0.0056) | (0.0265) | (0.0236) |
| Lever | 0.0509 | 0.0806*** | 0.0500*** | 0.0780 | 0.0792 |
| | (0.0567) | (0.0214) | (0.0128) | (0.0510) | (0.0526) |
| Sale | −0.0299 | −0.0309*** | −0.0295*** | −0.0308 | −0.0341 |
| | (0.0193) | (0.0061) | (0.0032) | (0.0201) | (0.0208) |
| ROE | −0.0125 | −0.0053 | −0.0125*** | −0.0040 | −0.0034 |
| | (0.0181) | (0.0050) | (0.0032) | (0.0141) | (0.0134) |
| Size | 3.0485* | 2.6821*** | 3.1051*** | 2.5499* | 2.9541* |
| | (1.6318) | (0.4235) | (0.2268) | (1.3976) | (1.5425) |
| Ggdp | 0.2785 | 0.3268* | 0.2623** | 0.3406 | 0.1022 |
| | (0.4017) | (0.1849) | (0.1112) | (0.3147) | (0.4485) |
| lngniper | −9.3719 | −4.3420 | −9.4260*** | −4.3027 | −3.7091 |
| | (8.3834) | (2.9438) | (2.0411) | (5.8706) | (9.3562) |
| Constant | 57.5083 | 9.6010 | 57.7098*** | 10.5221 | −0.0034 |
| | (87.0598) | (30.7993) | (21.6590) | (65.2207) | (98.6860) |
| Year effect | control | control | control | control | control |
| N | 1,529 | 1,529 | 1,529 | 1,529 | 1,529 |
| AR(2) | 0.7345 | 0.7597 | 0.7670 | 0.8169 | 0.9636 |
| Sargan test | 0.2262 | 0.1576 | 0.2345 | 0.1987 | 0.2013 |

*Notes:* This table reports the regression results for dynamic investment models. Models M1 to M5 are estimated using Arellano and Bond's (1991) GMM approach. English is a dummy variable that denotes a system of common law legal origin. Scandinavian, French, German and China are dummy variables that denote four subgroups of a system of civil law legal origin. $L.I_{i,t}$ is the first-order lag value of investment. AR(2) tests for second-order serial correlation in disturbances. P-values of the Sargan test for overidentifying restrictions, under the null of valid instruments, are reported. Robust standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are given in Table 3.

It is noted that RE investment in China shows no sensitivity to either cash flow or Tobin's Q, though the coefficients are negative, as expected. Certainly, this country is an enigma. Seen as one of the world's worst polluters, it has made considerable investments in RE in recent years and is becoming the dominant force in global renewable energy (IEEFA, 2018). Arguably, this recent spurt in investment should have begun to offset a scarcity of RE investment in previous years, reducing sensitivity, albeit not yet to a significant level, as our result shows. However, we recognize that it takes time for such policy switching to generate relevant and sufficient data from which justifiable conclusions can be drawn. La Porta, Lopez-de-Silanes and Shleifer (2008) subsume socialist states into the civil law grouping because of a paucity of data, and China's comparatively recent involvement in RE developments has presented us with similar issues, due to its shorter legacy.

*Renewable energy investment versus traditional energy investment*

As shown in Table 5, our baseline regressions, in general, support H1 and H2 in respect of RE investment. This empirical evidence, however, may be representative of the nature of the energy industry as a whole rather than being a unique feature of the renewable energy sector itself. Although its product, like theirs, is one of the primary inputs to the economy, companies in the RE sector are distinctively different from other power companies, since they are small, risky and prone to periodic slumps; have high start-up costs; and are unlikely to generate positive returns until many years have passed (Justice, 2009). Above all, RE companies have a mission to improve the environment and seek to achieve the ESG principles of responsible investment. Their ability to do so, however, depends on national policies to support their activities. This renders RE investment highly sensitive to changes in government policy determined by strategic priorities and political considerations.[5] To confirm that our results in Table 5 are ascribable to the RE sector, we conduct an analysis of the TE sector, detecting a difference attributable to the discriminative nature of RE investment. The results are reported in Table 6.

It is evident that the results of investment in the TE sector are, to a certain extent, different from those of the baseline regressions for RE investment. Companies in Scandinavian civil law countries are less sensitive to cash flow in their TE investment ($-0.8885$, $p < 0.10$) compared to RE investment ($-0.1125$, $p > 0.10$). This may be accounted for, in part, by Sweden's continuing dependence on nuclear energy for approximately 40% of its electricity (Milne and Richard, 2016; World Nuclear Association, 2019a), whose production is supported by tax relief. Sweden's government has specifically removed a capacity tax, which accounted for a quarter of the cost of nuclear power in 2016, as a means of encouraging reduction of its carbon footprint (IAEA, 2018). Finland also generates 30% of its electricity from nuclear power and plans to increase this to 60% before 2030 to reduce its dependence on coal (World Nuclear Association, 2019b)[6] and to help it achieve its carbon reduction targets by 2035. These are huge civil engineering projects on a national scale, instigated by governments, guaranteeing long-term, stable income streams by means of subsidies, and thereby reducing TE companies' sensitivity to cash flow.[7]

In respect of Q sensitivity within the TE sector, there are some identified differences in comparison to the RE sector. As expected, firm investment in a common law system is responsive to growth prospects in TE investment (0.7494, $p < 0.05$), although to a lesser extent in comparison to RE investment (0.9322, $p < 0.05$). With respect to civil law systems, investment in TE shows

[5] For example, China responded to the over-supply of electricity to the grid because of the rapid creation of windfarms by turning off turbines to limit windfarm production to 85% of capacity (Harrabin, 2016).

[6] Four of Finland's nuclear power stations will cease production in 2027, 2030 and 2038, respectively. One new reactor, the Okiluto 3, is predicted to come on stream in 2019 and has a decommissioning date of 2075. Construction of a second reactor, Hanihikiu 1, has a planned starting date of 2019 and will become operational in 2024 (World Nuclear Association, 2018).

[7] In 2016, the Swedish government announced that it will build up to 10 nuclear reactors in the coming years to replace its 8 existing reactors, which are ageing and due to be decommissioned (Milne and Richard, 2016). As part of its earlier policy to discriminate against nuclear power production, in the late 1990s Sweden imposed a capacity tax, which accounted for a quarter of the cost of nuclear power, with the industry paying SEK 4.5 billion annually by 2014 (World Nuclear Association, 2019a). Following representations from the industry, the government agreed to phase out the tax by 2019.

no sensitivity to growth opportunities (−1.0317, $p > 0.10$) in the Scandinavian civil law countries, which is in contrast to lower sensitivity of RE investment (−1.1150, $p < 0.01$). This is arguably because Nordic countries are strongly committed to becoming virtually 'fossil free', with Denmark, Sweden and Norway pursuing aggressive policies to achieve 100% RE power generation, or carbon neutrality, by 2050 (Sovacool, 2017). Sweden plans to phase out nuclear reactors by 2045 (IAEA, 2018), although it will rely on this low-carbon source of energy in the meantime to help reduce its carbon footprint. These policies suggest that power supply from traditional sources will diminish over time, making them progressively less attractive to developers and investors, since a lack of overt support for fossil fuels and nuclear energy in the long term must raise doubts in their minds about the prospects of growth in what are obsolescent, 'sunset industries'.

Traditional energy investment in German civil law countries shows significantly lower sensitivity to Tobin's Q (−3.2336, $p < 0.01$) compared to RE investment in Table 5 (−0.9836, $p < 0.10$). Arguably, this may be attributable to the heavy dependence of Germany itself on large imports of fossil fuels (Clean Energy Wire, 2018) and its strategy of building conventional power stations (Acid News, 2018). Despite this government policy of replacing existing conventional generators, since the long-term aim is to substitute them with sustainable energy sources, it is clear that there is no future for investment in TE such as coal-fired power generation, which will be phased out by 2038 (Clean Energy Wire, 2018), thus reducing its sensitivity to Tobin's Q significantly.

Similar considerations apply to French civil law countries, whose TE investment also shows lower sensitivity to Tobin's Q (−0.5566, $p < 0.10$). It is well established that 75% of the electricity in France is generated from nuclear power and the country is a net exporter of electricity, earning €3 billion a year from this trade (World Nuclear Association, 2018). But its nuclear reactors are ageing and in need of imminent replacement (Ministre de l'Environnemont, de l'Énergie et de la Mer, 2016); and since it is unlikely that RE alternatives will fill the gap, more will have to be built. Albeit these are government-sponsored civil engineering projects, with stable investment finance underwritten by taxpayers, they do not offer investors the promise of long-term growth, due to their being gradually replaced by sustainable energy sources, so firms' investment sensitivity to Q reduces.

Overall, there are clear differences between RE investment and TE investment in both common and civil law countries, which are consistent with the nature of investment. Therefore, these results confirm the rationale when RE power generation is analysed as a separate entity.

### *National governance and renewable energy investment*

The third set of hypotheses of our study focus on the extent to which country-level governance influences RE investment under the two broad legal systems of common law and civil law. The effectiveness of a legal system depends on the capacity of a country to enforce its law, the quality of its regulation and the effectiveness of voice and accountability (Ioannou and Serafeim, 2012). To test these hypotheses, we examine the interactions of three country-level governance variables, regulatory quality (Reg_q), rule of law (Rule_l), and voice and accountability (V&A), with cash flow and Tobin's Q, respectively, and compare the joint effects between the two legal systems. Table 7 reports the joint effects of country-level governance with cash flow on investment. Table 8 reports the joint effects of country-level governance with Tobin's Q on investment.

*Investment cash flow sensitivity.* Table 7 shows that country-level governance has no additional impact on investment cash flow sensitivity in a common law system, supporting our argument that the decision to invest is market-driven in such a regime, and that investment responds to the level of cash flow that a company has at its disposal, especially when access to external finance is restricted. Albeit the framework of country-level governance creates the environment in which negative consequences may follow illiquidity, the extension of capital for RE projects is determined by well-established norms of market principles. Government subsidies are inconsistently sustained because of political and commercial expediency, whereas lenders are primarily concerned with the need to minimize credit risk, basing their judgements on the ability of companies to generate adequate returns to repay their debts. These results reinforce our contention that a system of country-level governance does not modify the

fundamental principles governing financing provisions in market-based economies, and RE firms find themselves constrained by the availability of internal funds as a consequence.

In the case of civil law countries, the joint effects of regulatory quality ($-0.1686$, $p < 0.01$), voice and accountability ($-0.1098$, $p < 0.01$) and rule of law ($-0.1228$, $p < 0.10$) with cash flow demonstrate that a system of country-level governance exerts a supplementary influence in reducing RE firms' investment sensitivity to internal cash flow. These results are significant as they confirm that the socio-political ethos in civil law countries strongly favours ESG principles and responsible investment in sustainable sources of energy. For many years, Scandinavian governments have sought to create capitalist social democracies that promote the stakeholder perspective and pursue policies of universal social welfare (Kenworthy, 2014), supporting the contention that such principles permeate society at every level. Conditioned by this beneficent ethos, governments provide the subsidies most critical at the post-formative stage of development (Abdmouleh, Alammari and Gasli, 2015; Shrimali, Lynes and Indvik, 2015), thereby encouraging the provision of bank and private investment. Our evidence is consonant with Sovacool (2017), that energy transitions are 'significantly driven' by government policies and systems of regional governance. 'Subnational actors' from cities, municipalities, and even communes and local communities undertake even more aggressive decarbonization policies than those promulgated at a national level, empowering Scandinavian countries to achieve the highest levels of sustainable energy growth (Sovacool, 2017). As we have also noted, Germany pursues a similar form of 'welfare capitalism', in which companies adopt a stakeholder perspective (Dore, 2000), while civil law countries sustain what Strand, Freeman and Hockerts (2015) describe as cooperative business and institutional systems. In these democratic civil law countries, the powerful influence of national-level governance motivates companies to follow policies of openness and transparency, reinforcing their CSR credentials and giving them improved access to finance (Cheng, Ioannou and Serafeim, 2013). The combination of all these elements demonstrates consistent support for our contention that a benign social environment, operationalized in the fabric of country-level governance, reduces financial constraints for RE projects in civil law countries, which clearly distinguishes them from their counterparts in common law countries.

*Investment Q sensitivity.* Table 8 shows that the coefficients on the interaction term, $GV_i \times Q_{i,t}$, are positive but insignificant in the common law system, indicating that country-level governance has no additional effect on investment Q sensitivity. This may be due to there being insufficient observations from which to derive significant results. With respect to the civil law system, country-level governance measures also have no additional impact on investment Q sensitivity, which is consistent with our contention that the ideals of social welfare infuse all levels of society, creating a beneficent consensus. This underpins the policies of governments and motivates the decision-making of institutional and corporate actors, as well as individual citizens, making them of one accord in their desire to promote the sustainability agenda. Since business behaviours already fully reflect these precepts, the overarching system of national governance cannot bring a supplementary influence to bear. Hence, its interaction with Q will be insignificant.

### *Renewable energy investment excluding investment in China*

Developed countries have dominated the world's renewable energy development from the outset, but recently emerging countries have begun to catch up, introducing new dynamics to the overall picture. China, most notably, has invested substantially in renewable energy since 2013, and total investment in RE exceeded that of the EU and the USA, ranking it first in the world in 2015 (Zhang *et al.*, 2016). To make a firm commitment to its ambitions, the nation has granted a strategically important position to renewable energy, and the National 13th Five-Year Plan for the period 2016 to 2020 sets a target of a 15% share in total primary energy consumption by 2020 and 20% by 2030. In 2017, China also established a nationwide carbon trading platform, clearly signalling its intent to control conventional energy output. In the same year, its investment reached 45% of the global deployment of RE, and the nation is predicted to dominate the sector in the coming decade (Bloomberg, 2018), aided by a strongly centralized

political system and a powerful governance command structure.

Despite considerable investment by China in recent years, our baseline results in Table 5 do not show a statistical significance in investment sensitivity to cash flow or prospects of growth opportunities. To ensure that our conclusions on H1 and H2 are independent of a 'China effect', we think it prudent to exclude this country from our estimations when performing the analysis of the samples. The results are reported in Table 9.

The results show that RE investment in common law countries is sensitive to cash flow (0.1079, $p < 0.10$); whereas RE investment in German law countries is less sensitive to cash flow (−0.1158, $p < 0.05$), in comparison. With respect to Tobin's Q, RE investment shows positive sensitivity for common law countries (0.8737, $p < 0.10$), but much lower sensitivity for Scandinavia (−1.3440, $p < 0.01$). These results display consistent directionality, in terms of their signs and significance, with those reported in Table 5, confirming our principal findings.

These results reinforce our argument that market forces have greater sway in common law jurisdictions and that government intervention is less likely, whereas the stakeholder perspective and CSR principles prevail in civil law jurisdictions. The lack of significant influence from China is arguably because its investments, albeit substantial in recent years, have not been sustained over a sufficiently long period to contribute enough time series data. As we suggest, however, this is likely to change in the not-too-distant future, at which point the increase in available data will make it possible to reassess China's impact on the trajectory of RE investment. As La Porta, Lopez-de-Silanes and Shleifer (2008) observe, without sufficient long-term data it is difficult to generate objective evidence to determine the precise influence of China's inclusion in our models.

### *RE investment: GMM estimation*

To ensure the robustness of our results and address endogeneity, we further estimate the parameters in Eqs (1)–(4) by the GMM (Arellano and Bond, 1991). All the variables are first-differenced to remove the individual firm effect. The parameters in the models are then estimated using orthogonal conditions, in which the lagged values of endogenous variables are used as instruments. The results of the dynamic models are reported in Table 10. Model M1 reports the baseline results of the dynamic investment model. Models M2 and M3 report on the dynamics of RE investment of the common law system, and Models M4 and M5 report on the dynamics of RE investment of the subgroups of the civil law system.

Models M1–M5 show that the lagged investment, $L.I_{i,t,}$ is positive and significant across all models, which indicates the existence of a first-order autoregressive component in firm investment. The results of the majority of control variables remain similar to those in the baseline regressions reported in Table 5.

The main results for H1 and H2 continue to hold. RE investment in common law countries is sensitive to cash flow (0.0686, $p < 0.05$). The signs and directions of the coefficients on the civil law subgroups with cash flow interactions are consistent with those in Table 5. The Scandinavian group displays lower investment cash flow sensitivity (−0.4101, $p < 0.05$), arguably because policies supporting subsidies, favourable taxation regimes and other forms of financial backing are implemented extensively throughout Scandinavia. Norway and Sweden, for instance, have employed a Green Certificate scheme since 2010; while Denmark and Finland have used FiTs since 2009 and 2010, respectively (IRENA, 2018). The Swedish and Norwegian governments have also recently extended the life of their Green Certificate scheme, subsidizing RE deployment (Climate Action, 2017). Moreover, the availability of bank finance for RE in Nordic countries is conducive to reducing companies' financial constraints. For example, the Nordic Investment Bank offers loans repayable up to 25 years (Nordic Investment Bank, 2019), which matches the current duration of an RE development (Justice, 2009).

With respect to Tobin's Q, RE investment shows positive sensitivity for common law countries (0.5724, $p < 0.05$). The results for the civil law subgroups are consistent with those of the baseline model, in terms of direction and significance. The GMM results corroborate H1 and H2, reinforcing our contention that differences between RE investment decisions in common and civil law countries are fundamentally conditioned by countries' legal origin, which determines investors' and creditors' rights, the strength of legal protections, and the nature of contract enforcement and accountability.

## Conclusions

Our study investigates, for the first time, the relationship between investment in renewable energy development and the legal origin of the country in which an RE firm operates. We examine 236 companies worldwide to determine to what extent, and in what ways, legal systems distinctively shape RE investment, and how this process is influenced by systems of national governance. Our findings offer instructive insights into the countervailing forces that both promote and retard the transition to sustainable sources of energy.

Our investigation provides evidence of the global imbalance in RE investment and an empirically based account of this phenomenon, concluding that the origin of a country's legal system, and the business principles to which it gives life, have a significant bearing on a nation's contribution to RE transition. First, we find that RE companies operating in market-based, common law systems place a high emphasis on the perceived value of projects when making RE investment. They face higher constraints when raising external finance because RE is perceived to be risky, with high initial cost and positive returns not accruing for 20 to 25 years (Justice, 2009). Our evidence supports the argument that the primacy given to the 'shareholder perspective' in the laissez-faire market economies prevalent in common law countries accounts for the disinclination of companies to invest in RE. This ethos also increases governments' political circumspection in their decisions to grant financial incentives and makes finance providers cautious when deciding whether to support developments. Our evidence suggests that RE investment in common law countries is as much a socio-political as a commercial issue and that overcoming financial obstacles depends on societal, as well as fiscal, change at a fundamental level of the market-based system.

Second, we observe a significant difference in RE investment under civil law systems. Companies in such jurisdictions face lower financing constraints in RE development, and display lower sensitivity to their investments' growth prospects, than their counterparts in common law countries because of the prevailing ethos of the social and business environments in which they trade. The 'stakeholder perspective' that prevails in civil law countries engenders a cooperative business culture in which banks are willing to invest in companies professing ESG credentials. Governments pursue policies of centralized allocation and control, and are strongly committed to eliminating carbon-based sources of energy and to being fossil-fuel-free by 2050 (Sovacool, 2017), and this strategy is an objective measure of their fiscal and social stance. The 'welfare capitalism' that such countries practice facilitates RE development by motivating financial actors at regulatory and corporate levels to strive for social well-being.

Third, our analysis demonstrates that the influence of systems of country-level governance varies in relation to legal origin. In civil law jurisdictions, this governance facilitates RE investment because ESG principles are predominant societal goals, with both government and private lenders advancing finance for projects that satisfy 'green' credentials, thereby reducing firms' financial constraints in RE development. Arguably, the precepts favouring social wealth creation, explicitly encouraged by the country-level governance system, are consistently applied by regulatory and corporate actors, uniting them in a benign alignment of *principles* that gives impetus to the transition towards carbon neutrality. Without such powerful endorsements, companies engaged in RE developments, irrespective of their geo-political location, or of their innate desire to contribute to social well-being, will find it difficult to raise finance for such high-risk investments. Conversely, in market-based, common law countries, erratic government support for RE projects (Victor and Yanosek, 2011) results in periodic retrenchment because of opposition from consumers, who bear the cost of subsidization (Barradale, 2010; Pearson and Watson, 2012; Shrimali, Lynes and Indvik, 2015). The 'boom-and-bust' growth pattern that this creates discourages the private sector from extending financial backing, as this would run counter to the fundamental business principles that condition funding decisions. Theirs is a market-based decision alone, and therefore the system of country-level governance can bring no supplementary influence to bear on financial providers in their decisions to grant funds.

Overall, our study contributes new evidence of the contention between the opportunity costs of forgone economic gains and the pressing need to counter the effects of global warming, demonstrating how this conflict retards the transition from fossil fuels to renewable sources of energy and suggesting how development can be

stimulated by government backing, private investment, societal engagement and the alignment of national strategies. Democratic civil law countries have apparently achieved greater progress in overcoming impediments to this transition than their counterparts in common law systems, arguably because their adherence to CSR and ESG principles, underpinned by political regimes strongly supportive of social welfare, inspires development. How, therefore, can we use this knowledge to accelerate the transition in those countries where RE deployment, albeit achieving significant growth in recent years, has been more problematical because of inconsistent government backing and a lack of commercial engagement? Does surviving the threat of climate change require us to consider citizens' idealism as well as political obstacles, commercial expediency, financial pragmatism and national idiosyncrasies that erect barriers to RE deployment? Might it be that the successful transition to carbon neutrality requires a social, as well as a fiscal, revolution? If so, is it possible for government to exert a transformative influence on a culture implicit in a legal system and, in so doing, engage public support in removing obstacles to RE investment? Research into these and related issues is vital if we are to develop effective policies and actions at national and global levels to drive forward the transition from carbon-based to sustainable sources of energy.

### *Some further thoughts*

The urgent need to arrest the progress of climate change is one of the most pressing, complex and controversial issues confronting the world. The lack of consistency in national approaches and the absence of effective supranational coordination threaten to undermine evolving strategies to forestall the consequences of climate change. The evidence presented to us of changes in weather patterns due to global warming (IPCC, 2018), causing reductions in the polar ice caps, shrinking glaciers, and rising sea temperatures and sea levels, appear to confirm scientists' worst predictions about the perils that we face. Swift and concerted action is thus imperative; and our research, building on the research of others, has identified several ways to overcome obstacles to progress.

First, we note that national rather than international approaches to RE development have appeared to be the norm. Some progress has been made, with 90 countries, states or provinces setting targets for at least 50% renewable electricity in 2017 and 128 countries having regulatory policies for the power sector (Goworek *et al.*, 2018; Renewables, 2018). Mandatory carbon reporting is now enforced in the EU and in a total of 40 countries across the world, with companies matching varying criteria required to report their greenhouse gas (GHG) emissions (Carbon Footprint, 2019). However, these positive steps have to be viewed against a background of confounding evidence of inconsistent and unbalanced development. China, Europe and the USA accounted for 75% of RE investment in 2017. In the same period, subsidies for RE amounted to US$140 billion while subsidies for fossil fuels were US$360 billion (Renewables, 2018); while the UK planned to allocate a mere £60m for the next round of renewable energy funding (Clark, 2019). Although the G20 reaffirmed its commitment to phasing out 'inefficient fossil fuel subsidies' (International Energy Agency/OECD, 2018), progress is slow and unstable. Granted that the EU imposes targets on member states, there seems to be a lack of uniformity in national policies worldwide, with inconsistent progress between nations. Moreover, while some countries seek to embrace RE policies, others continue to pollute the world's atmosphere on a massive scale. The global warming conundrum calls for the creation of a system of global governance to coordinate the world's response to the climate change crisis, extending and enforcing mandatory regulations and supranational strategies and action plans to address the concerns and recommendations of the Stern Review (2006).[8]

Second, social acceptance is critical to success, especially at this stage of consolidation in sustainable energy development. The cost of investment in RE is high and positive returns may not be achieved for many years, so market solutions are unlikely to be effective in the short to medium term without government backing. However, the social burden imposed by subsidies falls primarily on consumers, resulting in a political backlash

[8]The Stern Review (2006) asserts that an expenditure of around 1% of world GDP per year is needed to effect environmental improvements, whose beneficial outcomes will more than compensate for their cost. The report also notes that developing as well as advanced nations must adopt such policies if global warming is to be averted, albeit that they have limited economic resources.

that compels governments to reduce, or even withdraw, financial support for RE. Social acceptance is therefore a prerequisite for sustained development, requiring the approval of both commerce and communities, and national and local governments must do more to persuade their electorates of the dangers of climate change and the benefits to be gained from RE investment. The failure to convince many ordinary citizens of the perils of global warming must be confronted, since millions of voters make their feelings known at the ballot box and are likely to elect leaders who share their views.[9]

Arguably, grassroots protests against the costs to consumers of developing renewable sources of energy, such as the recent *gilet-jaune* protests in France, demand to be countered by grassroots support for investment, engaging public sympathy, such as that expressed by the Extinction Rebellion demonstrations in the UK and elsewhere.[10] There is a growing awareness of the gravity of the crisis that we face, especially among the younger generation, who have the most to lose from global warming.[11] The power of public idealism that manifests itself in such movements must not be underestimated, and a proselytizing approach could well convince the sceptics where rational argument has so far not gained universal acceptance. In addition, shareholder activists and institutional investors should coordinate their campaigns to bring even greater pressure to bear on managements, demanding that companies adopt climate-friendly policies and exposing their transgressions at AGMs to public criticism, thereby threatening share prices (Sustainability, 2018). Undoubtedly, government intervention to overcome public resistance, supported by global, public education and engagement programmes, is essential if RE development is not to stall, as echoed by Shrimali, Lynes and Indvik (2015). Policy-makers, however, need to exercise caution as they tread a narrow path between the pragmatic and the ideal if social acceptance is to be secured.

Third, business leaders need to create sustainable business models to support RE development. As advances in technology are starting to drive down the costs of installing RE infrastructure, investments in what is seen as a high-risk industry are beginning to show signs of positive returns (Bloomberg, 2018). This growing market, with inward investment in China standing currently at US$2.3 trillion (Bloomberg, 2018), has much to attract entrepreneurial interest, and first-movers may eventually be able to exploit improvements in technology and economies of scale. Surges in investment, albeit stalling periodically (Shrimali, Lynes and Indvik, 2015), will surely engage the attention of international business leaders and finance providers as the RE industry matures and installation costs continue to fall. At this stage of development, global players should adopt an international portfolio investment strategy, while integrating new skills and rapidly emerging technologies and innovations, laying down the foundations of a sustainable energy sector and promoting the commercialization of renewable energy markets. In the meantime, managements must develop control systems, governance structures and procedures within their organizations to mitigate and ultimately eliminate climate risk. Without such approaches and the establishment of feasible cross-country investment portfolios and business strategies, progress will continue in its present, disorganized pattern.

Fourth, it is clear from our research that financial resources are fundamental to the sustainable development of RE technology. Conventional markets alone will not provide a solution, especially in common law countries; but even in civil law jurisdictions, where strong CSR principles tend to support RE deployment, the costs imposed by subsidization have not been universally accepted. Increases in power bills, caused by rising wholesale and environmental costs, have provoked public anger and frustration across Europe (Bate, Barteczko and Twidale, 2019). The controversial nature of government subsidies, paid for by increases in power bills, suggests that this cannot be a long-term strategy for RE development, and that commercial and socially acceptable financial support mechanisms need to be devised. Many countries are starting to issue

[9]The unilateral withdrawal of the USA from the Paris Accord on climate change, in the aftermath of the presidential election of 2016, is an indication of the countervailing political pressures that RE development confronts.

[10]'Extinction Rebellion is an international movement that uses non-violent civil disobedience in an attempt to halt mass extinction and minimize the risk of social collapse': https://rebellion.earth.

[11]Children across the world have recently gone on strike from schools to join mass marches and demonstrations against global warming. They claim that the older generation are indifferent to the plight of the young, questioning the point of attending school when their future will be destroyed by climate change. (BBC News, 2018, 2019).

green bonds (Climate Bonds Initiative, 2018), but fund managers have called for more aggressive extensions of such schemes, suggesting that 'green gilts', with government-guaranteed capital and income, would attract significant levels of investment (Walker, Zhang and Ni, 2019). Governments must do more to urge conventional banks to offer RE companies with strong ESG credentials easier access to investment finance. Financial markets and institutions should play a pivotal role in developing innovative carbon-neutral financial instruments and green derivatives to satisfy the demands of RE investment. Unconventional methods of raising capital, such as marketplace lending and large-scale private equity, could also play a part. Crowd-funding, in particular, has raised substantial sums from an uncritical public for socially inspired causes, suggesting that this and the development of other ethical sources of finance might help to inspire the idealism of a disenchanted public. Ideologically based forms of financing could succeed where conventional methods have so far made limited progress, and innovative approaches are, therefore, crucial to transmit a strong and timely impetus to the development of this fledgling industry.

There are no easy solutions to this global conundrum, and a quotation from a philosopher whose country appears destined to play a significant role in RE development seems apposite: 'The journey of a thousand miles begins with one step' (Lao Tzu). We have already set foot on a long and arduous road, and our hope must be that it will lead to a destination where environmental pollution is eliminated and its existential threat removed.

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Jia Liu is Professor of Finance at the University of Salford, UK. Her research interests focus on corporate finance, corporate governance, asset pricing, and energy finance and economics. She has published in leading finance, economics and business management journals. Her research has won prestigious awards, including the British Academy of Management and European Management Journal Best Paper Prizes. She is Associate Editor of the *British Accounting Review* and *International Review of Financial Analysis*, among others.

Dayong Zhang is Professor of Financial Economics at Southwestern University of Finance and Economics, China. His research interests cover energy economics, energy finance, banking and finance, general economic and financial issues in emerging economies. He is the co-founder of the China Energy Finance Network and an associate editor of a number of journals, including the *International Review of Financial Analysis*, *International Review of Economics and Finance* and *Finance Research Letters*, among others.

Jing Cai is a lecturer in the School of Accounting at Southwestern University of Finance and Economics. Her main research interests include banking, corporate finance, energy finance and household finance. Her work has been published in journals such as the *Journal of Banking and Finance*, *European Journal of Finance*, among others.

John Davenport is a Fellow of the Association of Chartered Certified Accountants and holds a PhD from Manchester Business School. He has integrated commercial experience and an academic career, combining pragmatic and theoretical concepts. He has engaged in research in financial accounting, corporate finance, corporate governance and energy finance, publishing in management journals such as the *British Journal of Management*. He has held visiting positions at a number of academic institutions in Europe.

## Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Table A1.** Pearson correlation matrix
**Table A2.** Multicollinearity test using Variance Inflation Factors (VIFs)